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LESSONS OF THE GREAT ENGINEERING STRIKE IN ENGLAND.

By J. Stephen Jeans.

THE struggle that is now going on in Great Britain for the establishment of an eight-hour day in the engineering industries of that country has a more than merely local interest. It points a valuable moral, and inculcates a number of useful lessons, to those engaged in the same and kindred industries in other countries, and not least so in the United States. I have thought, therefore, that an account of the movement for an eight-hour day, and what it involves, from the point of view of both parties to the controversy, may be of special value to the great engineering industries of America, where the eight-hour day has already, in some cases, passed from the merely academic platform to the region of actual practice, and where the British experience of to-day may easily be reflected to-morrow.

Although the eight-hour-day movement has an interesting historical side, I do not purpose to touch upon it, beyond stating that this limit of work has been a desideratum and aim of certain unions for many years. One of the oldest shibboleths of modern labor is expressed in the doggerel lines:

> Eight hours' work and eight hours' play,
> Eight hours' sleep and eight bob a day;

but the cases in which this goal of the worker has been reached have been very few. In Great Britain, the demand has been formulated with unusual force and persistency on behalf of two leading industries widely apart in their conditions and characteristics. The miners, or at least a majority of them,—for the movement has not their universal endorsement,—have agitated for years past for an eight-hour day from bank to bank, which would, in a large number of cases, mean

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six hours of actual work; while in the engineering industries, which secured a reduction of the hours of labor from ten to nine as far back as 1870, a considerable pressure has been brought to bear on employers during recent years to concede a further reduction from nine to eight hours, without any corresponding reduction in wages. The nine-hour day was won at "the point of the bayonet," having been preceded by a long and disastrous strike. Until now, however, there has been no actual strife between employers and employed with a view to the establishment of an eight-hour day, although the matter has been more or less agitated ever since the nine-hour movement was inaugurated more than a quarter of a century ago.

The workmen, in making the present demand, claim that a reduction in the hours of labor is required, in order to give the workmen more time for study and recreation; that the proposed system would enable the workman to start work in the morning with his breakfast, and consequently in a fitter condition for actual labor; and that the effect of reducing the hours would be to provide more employment, and consequently to reduce the number of artisans out of work. Another claim has been made, strangely inconsistent with the one last-named,—namely, that, under the improved social conditions assumed, the average workman can do as much work in eight hours as in nine, chiefly because he will be more fit, but also because there will be less lost time in getting to work, and only one break in the day, instead of two.

On the other hand, the employers refuse to admit that the claims of the workmen are reasonable, or their reasoning accurate. They argue that the reduction in the hours of labor would mean an increase of five to ten per cent. in the cost of production, which would be disastrous in face of the severe foreign competition now prevailing; that already they have the utmost difficulty in securing orders against continental countries and the United States; that, as all machinery in well-regulated shops is already worked to its utmost capacity, it would be impossible to make up for lost time; that, apart from this controlling aspect of machinery, their experience of the nine-hour-day change did not show that workmen were ready or competent, as a general thing, to do as much work in a shorter as in a longer period; that establishment charges could not be reduced in proportion to the reduction in hours; that the change would increase, *pro rata*, the maintenance of machinery; and that, if the eight-hour day is to be adopted, it should be accompanied either by a reduced rate of wages, or by the removal of the restrictions at present imposed by the workmen's unions, in reference to piece-work, apprentices, over-time, the working of machine-tools, and other matters.

The attitude which the employers have taken has been to a large extent affected, if it has not been actually determined, by the ascertained facts as to the conditions prevailing in competitive countries. Already the hours of labor in Great Britain—at any rate in the engineering industries—are less than those in any competing country, and are materially less than in Germany, which is England's chief competitor. Till now, however, British manufacturing engineers do not appear to have been much hurt. It is true that they have had experience from time to time of serious and prolonged depression ; but the last two years have been the most active and satisfactory that they have ever had. The value of the British exports of mining, agricultural, textile, and other machinery has increased considerably, and most of this business has, of course, to be carried on in the face of the keenest competition. Home industries provide, moreover, for a very large volume of work that is little, or not at all, affected by foreign competition, such as that done for the navy,—on which about eight millions sterling is being expended this year,—and the building of engines and other equipment for the enormous ship-building trade.

The present strike, however, is not merely a function of the demand for an eight-hour day. In a larger and wider sense, it is a practical protest of capital against the repeated and persistent attempts of the workmen to control the business of their employers.

The present dispute affects about ten leading trade unions in the country. Some of these are among the strongest unions in Europe. Foremost in this category stands the Amalgamated Society of Engineers, which was founded about half a century ago, and has at present a membership of nearly a hundred thousand. The other unions include the Steam Engine Makers' Society, the Amalgamated Society of Tool-makers, and the United Machine Workers' Association.

It is not, however, to be supposed that all the skilled artisans in the country connected with the engineering trades are members of these and kindred societies. The number of such workmen is not accurately known, but it is believed to be near half a million ; the trade unions have not more than one-fourth of this number in membership.

The employers in the engineering industries of Great Britain have long felt that they were greatly handicapped in their competition with foreign countries, and more especially with the United States, by reason of the tyranny of the trade unions. In no other country is the system so powerful, so dictatorial, so exacting in its demands, so unscrupulous in its methods. The employer who stands the slightest chance of making reasonable progress in his business must always reckon with the trade-union programme, and must be ready to make concessions when the councils of these organizations require them.

Usually all questions of dispute are settled by makeshift compromise. It might be supposed that the State would, to some extent, come to the aid of the employers on the ground that the action of the unions was generally calculated to be in restraint of trade. This, however, is hardly an attitude which any government of late years has cared to take up. The individual member of parliament dare not take up an antagonistic attitude, or he would incur a serious risk of losing his constituency at the next election. The catching of votes is the chief end of the modern legislator. To "go one better" is the chief end of the government that would remain in power, or snatch that most coveted of all possessions from its rival. No government could hope to succeed that was pronounced against labor movements. In a large number of cases both the government of the day and the individual legislator are afraid to act, lest the hostility of the electorate should be roused. Sitting astride the fence has, therefore, become a favorite attitude on the part of both. Responsibility is declined wherever it is likely to make against the voters. Back-bone on labor questions is almost an unknown quality of British legislation, unless it should be exercised in laying some new burden on the employer. Each party competes with the other in the endeavor to prove that "Codlin's the friend; not Short." Rarely does a British statesman venture to say all that he desires to express. The stock-in-trade of the average politician, and especially of the so-called responsible minister, is usually vague generalities, which tickle the ears of the groundlings, but mean nothing in actual practice.

All this flabbiness induces the labor leaders to put on a bold front. They have long learned that, if they are to have their demands complied with, "they themselves must strike the blow." They know that they will not suffer much opposition from the government. They know that they can count on a large amount of outside sympathy and support from irresponsible philanthropists. The labor leader of to-day is a tactician, a disciplinarian, a wrestler, a soldier, a policeman, and a lawyer, all in one. He knows exactly how far he can go without being caught in the meshes of law, and the statute-book enables him to go a long way. He has many weapons at his command. Bluff, cajolery, persuasion, sympathy, fear, and force are each used in turn, according to the requirements of the case.

The chief complaint of the employers against trade unionism is, not that it attempts to secure higher rates of wages for the workman, or even shorter hours of labor, but that it is with their demands as with the Hollanders of the days of Hudibras:

> In matters of commerce the faulf of the Dutch
> Is giving too little and asking too much.

The employers would give a great deal to get rid of the trade-unionist tyranny in reference to piece-work, the apprentice system, and the conditions under which machine tools shall be worked. But at the same time that the trade unions insist on shorter hours or higher wages, they demand that piece-work shall, as far as possible, be got rid of; that the number of apprentices relatively to journeymen shall be strictly and most unreasonably limited, and that the individual workman shall be permitted to do perhaps not more than one-half of what he easily might do.

The rank and file of the employers in the engineering trades of Great Britain refuse to believe that as much work can be produced by the average workers in eight hours as in nine, or, as it is generally and more specifically put, in the proposed week of forty-eight hours as in the existing week of fifty-three hours. Such a reduction is equivalent to 9.4 per cent. in time, or to an increase of 10.4 per cent. in wages, taking the average wages of the skilled artisan at 33*s.* 4*d.* per week, which is the rate accepted by the trade-union officials. Assuming the wages paid in the engineering industries to be about one third of the total cost of production, the eight-hour day would involve, in wages alone, an increased cost of 3.47 per cent. It has, moreover, been computed that, on the basis of fifty-three hours, a man's time, in itself, is equivalent to the working charges of the concern, which would give a further increase of 3.47 per cent., or a total extra cost of 6.94 per cent., not including the inevitable increase of fixed charges due to the shorter day. On the other hand, employers in the engineering industries generally do admit that men working at their best on piece-work turn out much more work—say, from 25 to 30 per cent.—than men working on time usually do. But the workmen's union will not allow the men to work piece-work where the system is not already established. Their rules provide that a member of the society who takes piece-work where it is not already declared to be established shall be fined 20*s.* for a first offence and 40*s.* for a second offence, and shall be expelled for a third. Wherever the Amalgamated Society is strong enough to carry its own way, piece-work is disallowed and forbidden. Cases occur where members of their own societies in certain branches are allowed to work on piece, while those in other branches are not. Such a condition of things has led a well-known British ship-builder to caustically criticise "the incongruity in legislation which forbids the workman to contract with his free will, with his employer, for pecuniary aid in case of disablement by accident, and at the same time permits him to be compelled, *against his will*, to contract with a trade union for the arrangement of the terms of his employment."* The rules of the Amalga-

* Paper read by John Inglis before the Philosophical Society of Glasgow, March 27, 1894.

mated Society are tyrannical not only as against employers, but as against their own members, whom they coerce into practices and regulations of which a large proportion do not in their hearts approve. That, however, is another matter, and by the way. We are now concerned only with the question of how far the attitude taken by the unions affects the status of the employers and the cost of production.

There appears to be sufficient evidence of the fact that, the hours of labor being reduced in cases where the piece-work system is in force, the cost of production has not been materially affected. Some years ago the hours of women's labor in Germany were fixed by law at eleven as a maximum, with one hour's rest during the day, and an extra half-hour for workers who have households, when required. In nearly every case where piece-work is the rule, it was proved that the production had increased with the reduction in the hours of labor.* In some cases, when the hours were reduced, the speed of the machinery was increased, but the speeding of the machinery can be increased only in limited measure, and in well-organized factories the machinery is already being worked for all it is worth; otherwise there must be an avoidable leakage, which should not exist.

It is not necessary that we should here discuss the comparative merits and economies of piece-work and day wages. Every employer is cognizant of the greater facilities which piece-work, properly organized and directed, offers for economical production. No doubt the use of piece-work calls for greater supervision than the fixed-wage system. It has been found in engineering workshops, where repairs are carried on, that with piece-work there is a great tendency on the part of workmen to renew more parts than are actually necessary, and there is also a danger of material being wasted by unscrupulous workmen, especially if parts can be removed more quickly and easily by destroying them.† Nevertheless the general effect of the system is to benefit both employers and employed by increasing wages and reducing the cost of output.

The British trade unions describe piece-work, in the language of the rules of the Amalgamated Society of Engineers, as "one of the greatest evils" of our industrial system. The unions hold, or encourage the assumption, that under such a system the employer profits at the expense of the workman; that it often involves loss to the men, who do not always earn full wages and have to make up the deficiency; and that it has a tendency to reduce actual earnings to the lowest possible amount. The system is, moreover, described as an encouragement to "sweating," which is declared to be prejudicial to the workmen.

* Reports of German factory inspectors.

† Paper read on "Piece-Work in Car Shops," before the Western (U. S.) Railway Club.

From these ideas and prejudices against the piece-work system not a few strikes have taken place in England. One of the most notable occurred a few years ago at the works of Easton & Anderson, on the Thames. Returns were collected from the leading engineering firms throughout the country at the instance of one of the most influential associations of employers, which showed that the wages paid to individual workmen, engaged on piece-work, on an average of all the chief districts, was about 40 per cent. more than the weekly time-rating, and that weekly ratings were higher in districts where piece work is usual than where it is never resorted to. It was proved, also, that the percentage addition of piece-work balances was higher in those shops where the weekly ratings of the men were on the highest scale, showing that the best men are attracted to districts where piece-work is general. I may here add that the late Mr. Mundella, at one time president of the Board of Trade in Great Britain, computed that, of the two hundred and forty millions' annual value of British exports, fully 90 per cent. were made by piece-work,—a computation, which, if accurate, demonstrates the futility and unreasonableness of the hostility of some trade unions in trying to eliminate it.

It is only fair to add that piece-work, both in England and elsewhere, has been liable to abuse, and may have had to answer for abuses. As a case in point, the experience of the ship-building industry may be mentioned. When this industry was specially active some years ago, it was stated that in many instances the platers, whose time wages were 6*s.* per day, were earning at piece-work within a shilling of £2 per day, while their helpers, whose rating was 4*s.* per day, were earning at the same piece-work, only an additional shilling, or 5*s.* in all. It is natural that objections should be raised to this extreme disproportion in the distribution of piece-work benefits, and especially in an industry like ship-building, where stoppages are frequent. Reasonable employers fully recognize the importance of paying piece-workers with some regard to their ordinary time-ratings.

There are various other pending issues which have often led to strikes in Great Britain. The workmen have again and again called for conditions that virtually mean the suppression of over-time, demanding that each day's work should stand upon its own merits, and that over-time rates should commence each day as soon as the ordinary day's work is brought to a close, whether or not time has been lost during the day. This position was abandoned, and latterly the rule has been that fifty-four hours per week must be worked before over-time rates begin to tell, time and a quarter being paid for the first four hours of over-time of each day, and time and a half for additional hours thereafter, provided these fifty-four hours have been

worked and paid for at ordinary rates. But the workmen's unions would abolish over-time altogether, if they could, despite the fact that their own members flock from shops where no over-time is going on to those where it prevails, and despite the fact that, as the engineering trade is especially subject to periods of long depression and of great activity, often of short duration, they could not practically be debarred from taking advantage of brisk trade when offered.

There are still other directions in which trade unionists, in making a demand for shorter hours of work,—a demand with which, *prima facie*, most of us would sympathize, and which many of us would heartily support,—have made it extremely difficult for the employers to meet them, and have practically compelled an attitude of serious resistance. One of these is the limitation of the number of apprentices. Another is the limitation in the number of machines which a workman can attend to,—the union forbidding a man to work more than one machine, and in many cases more than one tool on each machine; while frequent attempts have been made to establish a minimum rate of wages, oblivious of the fact that, if it were sought to pay to a less efficient or less highly-skilled workman wages in excess of his fair remuneration, as measured by the value of his work, this could be effected only at the expense of his more efficient and more highly-skilled compeer. The spirit and practice of British trade unionism, in short, is the discouragement of individual effort or exceptional skill.

The employers are naturally rankling under a sense of the unreasonableness of the workmen in demanding shorter hours and daily wages at the same time under the conditions stated. If piece-work were generally adopted, the result would be different. In that case it is not probable that the demand for an eight-hour day would be so zealously prosecuted. But the employers object that the workmen want to have their cake and eat it too—to score at both ends, and that, too, in such a way as effectually to prevent the employers from recouping themselves from the loss that appears to be inevitable under the proposed new system, as now formulated.

The most curious phase presented by this question is the comparatively limited numerical strength of British trade unionism relatively to its vast influence as a social and economic force. Some years ago Mr. Frederick Harrison pointed out that, of the twelve millions of those who earned wages in Great Britain, less than one million were in union, so that "at the utmost trade unions affect substantially only the minority,"* while "the unionists are a mere fraction—the aristocracy of labor," which "is not now relatively growing." In

* Report of Industrial Remuneration Conference in London.

spite of exertions to create a sympathy for unionism, the system "in its average, and certainly in its lower types, tends rather to sectional and class interest; it divides trade from trade, members from non-members; and especially it accentuates that sinister gulf that separates the skilled and well-paid artisan from the vast destitute residuum."

After this review of the tyrannous attitude and vagaries of British trade unionism, American manufacturers may well feel that they have much to be thankful for. In American practice, as I am informed, there are no such restrictions on piece-work as in England, but each workman, acting on his own initiative, as a rule, makes his own individual arrangements. So far from any attempt being made to limit the number of machines or tools that a mechanic can tend, as in England, the American mechanic takes as many as he can, knowing that, the more he does, the better will be his remuneration. It is, consequently, not an unusual thing to find an American mechanic tending two, three, four, or even half a dozen tools, while his English congener is *forced by his own organization* to be satisfied with one. A uniform rate of wages, again, which is a desideratum with a number of British trade unions, would be scoffed at by the American, who insists on earning as much as he can, and practically applies in every-day life the sound and healthy principle that the race shall be to the swift and the battle to the strong. Surely, if all this teaches anything, it teaches the lesson of maintaining that individual liberty which the British workman has voluntarily sacrificed for a mess of pottage. From the point of view of international competition, at any rate, there can be no possible doubt of the demerits and disadvantages of the British system, which is practically a premium on the freer ideas and habits of the American citizen.

Recent conferences and inquiries have pretty well established the fact that English workmen, as a rule, are better paid, better fed, and work under more healthy, normal, and favorable conditions, than the workmen of any other country, and, in saying this much, I am not disposed to except even the industrial workers of the United States. It may be true—it probably is—that the American skilled workman not only has higher wages, but can make his money go further in respect of purchasing power. But no one who has compared the economic conditions of the two countries can fail to have observed that in the United States the average workman works for longer hours and under much higher pressure, so that he really gives more return for his wages than his congener in Great Britain.

It is not too much to say that no other country has suffered so much as England from conflicts between capital and labor. The annual loss to British industries from this source varies greatly from

year to year, but in the aggregate it must be enormous. The strikes of coal miners alone during the last five years are estimated to have entailed a total loss of ten to twelve millions sterling.

Attempts have been made by the establishment of courts of arbitration, by systems of conciliation, by coöperative movements, and by other industrial arrangements, to reduce the number and intensity of such disputes, but, if these expedients were generally of value, and especially if they were to be depended on, we should not now witness the strife that is pending in one of the most advanced and intelligent industries in the country.

Manifestly, the question that comes uppermost, in view of so serious a dislocation of industry as that which I have described, is that of how the parties and countries concerned can avoid such troubles in the time to come. This is a problem that stands as much in need of solution in the United States as in any European countries, and the attempts at solution furnished by American experience have not been unimportant. It is impossible in an article that has already reached such limits to discuss these, but the piece-work systems introduced at the Midvale Steel and Baldwin Locomotive Works, and at the works of William Sellers (incorporated), described in a previous issue of this magazine, may be referred to as entitled to special notice, if not to general imitation.

The most important and pressing problem presented for solution, so far as the United States are concerned, is that of whether the British situation or the American situation in relation to trade unionism is to be the industrial situation of the future. Neither country can stand still in view of the changing conditions presented by the great social upheaval that is going on all around. Labor is unquestionably more highly organized in Great Britain than in any other country. Is this not the inevitable result of Great Britain's priority of place as a manufacturing country? And, if it is due to that factor, is it not probable that in newer countries labor will acquire the same power and use it as remorselessly as it is now being used in leading British industries? If so, is it not probable that we are approaching a period when the troubles that have been faced and fought in Britain will engross the thoughts and efforts of American manufacturers? In other words, is the struggle between capital and labor being fought out in Britain once for all, or will it have to be gone over again, *mutatis mutandis*, in other industrial countries? Is the present British attitude of capital and labor the last word in this controversy, or may we look in the near future for conditions more nearly assimilated to those that prevail in the United States?

THE STRENGTH AND FAILURE OF MASONRY ARCHES.

By Henry Harrison Suplee.

THE arch is probably one of the oldest forms of masonry construction for spanning openings, examples having been found in China, in Egypt, in ancient Greece, and in Italy, while in medieval and modern times arches have played a most important part in the construction both of bridges and of buildings.

While we have no recorded evidence of the theoretical knowledge possessed by the ancient constructors, it is certain that until comparatively recent times the action of the forces in arches, and the manner in which the materials resist those forces, have been but imperfectly understood, nearly all the most important structures of this form having been built according to empirical rules, deduced from hard experience and the observation of preceding successes or failures.

From the time of Newton the theory of the arch has been discussed by innumerable writers, among whom, as the most noted, may be included Gregory, de la Hire, Coulomb, Eytelwein, Navier, Lamé, Poncelet, Moseley, and Rankine. All of these, with the exception of Navier and Lamé, seem to have accepted the so-called statical theory, stated in its clearest form by Coulomb in 1773, and treated with the greatest mathematical elegance by Moseley in England and Scheffler in Germany.

Since the introduction of railways, however, the importance of taking into proper consideration the heavier moving loads has caused the statical theory to be regarded as not altogether equal to the conditions, and the increasing knowledge of the properties of materials under stress, together with the widening appreciation of the importance of considering the question of elasticity, has led engineers to believe that the elastic theory should also be applied to the arch, whether built of masonry or of metal.

The elastic theory, as applied to arches, is due to the researches of Bauschinger, Köpcke, and others, and appears to have been first clearly stated by Winkler in 1867, followed by Weyrauch, in 1879, and Müller-Breslau, in 1886, and has been most fully confirmed by the important experiments made by the Austrian Society of Architects and Engineers from 1891 to 1893, and published in 1895.

Before proceeding to give some account of these "Austrian Ex-

periments" and the valuable lessons drawn from them, it may be of interest to examine in a rather elementary fashion what an arch really is, and what we ought to expect of it under various conditions.

Probably the first arch consisted simply of two massive stones, leaning against each other in the form of an inverted "V"; with proper choice of angle and suitable placing of abutment stones to receive the horizontal thrust at the bases, such a construction makes a strong and effective means of spanning entrances and other openings in buildings. It is in this manner that the entrance to the great pyramid is arched, and the load over the King's Chamber is discharged in the same way. This primitive form of arch, possibly suggested by observation of rocks in nature, occurs in many places in Egyptian architecture, and doubtless led up to the use of two inclined stones with a horizontal one between them above, this forming a true arch in the modern sense of the term, while the two-stone construction may be considered the germ.

Crude piles of stones, forming actual arches of several stones, are found in the so-called cyclopean structures, of which an excellent example is found near Epidaurus, in Greece.

In all these cases the structure is maintained in position entirely by the force of gravity held in equilibrium by the resistance of the material; and, as it was soon found by experience that arches of different shapes could be made stable by varying the loads upon various parts, it is not surprising that such theorizing as was at first made upon the subject was based entirely upon statical considerations, and assumed the arch to be composed of rigid, incompressible blocks, held in position solely by the force of gravity opposed by the crushing strength of the material. When moderate spaces are spanned by arches so massive that the stationary weight is greatly in excess of any moving load which can come upon it, this theory is not so far from the actual conditions as to reveal its defects. So we see the early structures of the Romanesque and Norman periods maintaining their equilibrium by a brutal excess of strength quite in keeping with the massive walls and narrow openings, but altogether unsuitable for modern conditions. When in later times attempts were made to lighten the structure, the artistic intuitions of the Gothic cathedral builders developed forms nearly in statical equilibrium and marvellously graceful in appearance, but even these frequently failed when applied to bridges of moderate spans and dissimilar conditions.

Coming down to more modern times, we find numerous attempts to investigate the real conditions and action of the forces in arches, especially for large spans; and the theory of Coulomb, expanded and developed by later authors, showed that the forces could be considered

as concentrated along a curved line, and that, so long as that line maintained itself within certain limits of the arch ring, the structure would be stable, but that, when it departed from those limits, the arch would fall.

When the arch is symmetrical and subjected to a symmetrically-disposed load, this equilibrium curve, as it is called, can readily be determined, both inposition and shape, either by analytical or by graphical methods, and the thrust and pressures in the arch determined with a degree of accuracy quite within the limits of construction.

When, however, in addition to the symmetrical and stationary loads, there are loads varying in magnitude and position, the problem becomes much more complicated, and the immense mass of writings upon the subject shows that its importance is recognized by engineers, and also that all are by no means of the same opinion regarding the correct solution of the problem.

As an analogy for the consideration of the general reader, the arch may be compared to a catenary, or curve formed by a chain fastened at both ends at points in a horizontal line and allowed to droop in a curve. So long as the chain is supporting only its own weight, or a number of uniform weights suspended from it at equidistant points, the curve will be symmetrical and determinate; but, when an odd weight is attached anywhere, the curve will be distorted, and its investigation greatly complicated. The catenary, when inverted, becomes the equilibrium curve for a similar arch under the same loads, all the directions being reversed, and all the tensions converted into thrusts.

The best illustration of the actual condition of affairs is that given by Professor Fleeming Jenkin, reproduced below.* Professor Jenkin takes a model arch, of which the voussoirs, or separate stones, are made with curved faces, so that they may assume various positions in accordance with the varying conditions; and he shows it subjected to various loads. Thus, in Fig. 1 the load is placed in the center, and, as the arch stones are free to rotate, the crown of the arch is depressed. Now, a line drawn through the points of contact of the curved faces gives us the real arch existing under these conditions, and we see at once that the highest point of the curve is immediately under the weight, and that, if the weight were removed, the stones would rearrange themselves, and the curve flatten at the top. When two weights are placed as in Fig. 2, the haunches are depressed and

FIG. 1.

* Encyclopedia Britannica, Art., Bridges.

the crown rises, and the equilibrium curve takes the reverse movement, rising at two points directly under the weights. Likewise in Fig. 3, the weight placed on one side causes a distortion which changes the form of the equilibrium curve, the high point being again under the load. As one writer has neatly put it, "the curve humps itself up to meet the load."

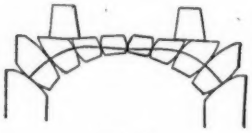


FIG. 2.

Now, to quote Professor Jenkin's words, "in the model each voussoir is free to roll, because the bed stones are curved. In an actual arch the bed joints are plane; nevertheless the stones do turn round to adapt themselves to the pressure, but the result of this rotation is to render the compression along the upper and lower halves of the stone unequal. One edge is more compressed than the other; the couple tending to turn the voussoir, and actually allowed to do so in the model, is met by an equal and opposite couple due to the unequal compression of the stone.

FIG. 3.

"This couple is the necessary result of a pressure which is not axial; an equilibrated polygon cutting the joints at various distances from the center is, therefore, as correct an indication of the actual forces present in an actual arch with flat joints as in the model with curved joints; but we must remember that, where the joints are flat, the pressure will be unequally distributed whenever the line of the equilibrated polygon does not cut the center of the joint. *Greater or less elastic resistance* in the stone corresponds to a greater or less curvature in the surface of the joint. A small distortion of the arch will restore equilibrium when the stone has a *high modulus of elasticity*.

"The ring with plane bed joints is in stable equilibrium, and adapts itself to new distributions of load for precisely the same reason as the model with curved joints, but in the one case the couple called into play to move the voussoir is actually cancelled by the new position which the points of contact assume; in the other case it is balanced by the equal and opposite couple resulting from the resistance to motion due to the hardness of the stone."

Under the old statical theory the stone was supposed to be rigid, and, when the equilibrium line approached too near the outer limit, "rotation" was assumed to take place, the joints on the opposite side of the voussoir opening and the entire structure suffering distortion. The only resistance which the stone was supposed to offer was based

on its ultimate crushing strength, and the question of its elasticity was not taken into account; indeed, its modulus of elasticity was rarely found.

It is evident, however, that, if we consider the material as possessing elasticity, the yielding of the voussoirs at the points under greatest pressure might cause a tendency to rotation, and consequent opening of joints, long before the crushing strength was approached, and that, when the load which caused this action was removed or shifted, the parts might resume their normal positions and relations without having suffered any permanent deformation, while, if the yielding to unequal pressure was sufficiently great, the portions under tension might be permanently injured by the action of loads much smaller than those which the old theory would consider serious.

The elastic theory having been considered and practically accepted for metallic structures, it became a question how far it was applicable to those of masonry. In order to solve this, as well as to add to the stock of experimental data upon the general subject of arches of various materials, the Austrian Society of Engineers and Architects appointed, several years ago, a committee composed of some of its most eminent specialists to investigate experimentally the behavior of large arches under known stresses, and to test the whole subject upon so large a scale as to furnish data of real practical value for future use in arch-design and construction. The report of this committee, published in the journal of the society and subsequently in a special reprint consisting of 131 folio pages and 27 large plates, is undoubtedly the most important publication on the subject of the arch which has ever been made. The technical details of the subject are too voluminous and mathematical to be given here, and for them the professional engineer must be referred to the original publication; but an account of the general nature of the tests and the results obtained are of so general interest and importance as to be worthy of general attention. The preliminary portion of the work consisted in experiments made upon small arches, such as are used in fire-proof building between floor beams and the like, and these need not be discussed here. The important tests were those made upon several large arches of different kinds.

Those in which we are interested were made upon four arches, each of 23 meters' (75.4 feet) span, 4.6 meters' (15.1 feet) rise, and 2 meters' (6.56 feet) width. Three of these arches were of materials in general use,—*i. e.*, rubble, brick, and concrete,—while the fourth was of the so-called Monier construction, consisting of concrete in which is embedded a network of round iron rods to assist in resisting the tension stresses.

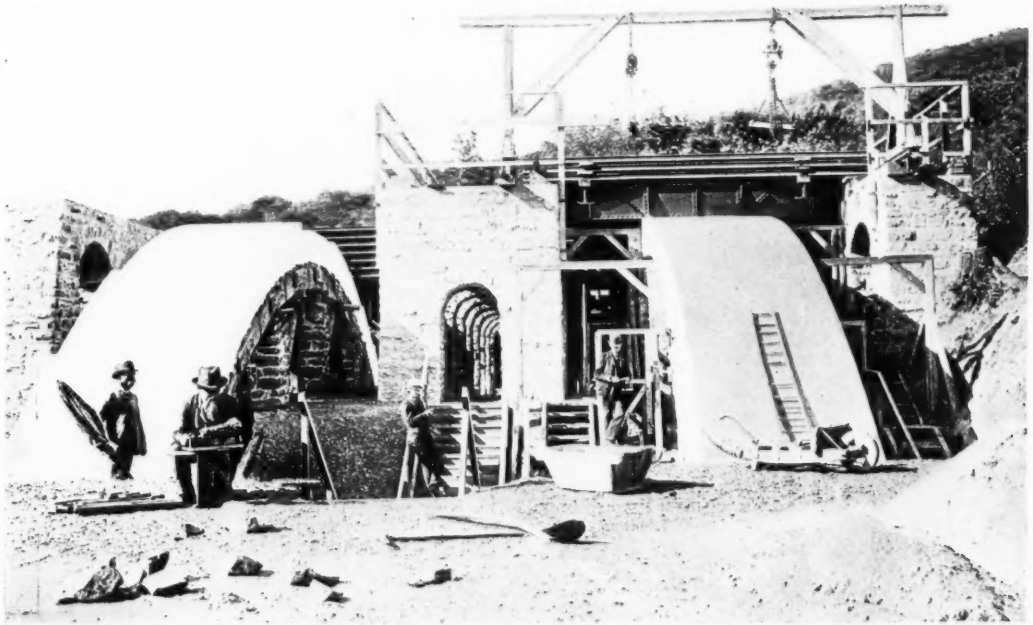
The location of the experimental arches was well adapted for the purpose, being on the line of the Western Railway at the Purkersdorf station near Vienna, and the general arrangements will readily be understood from the photographs, of which Fig. 4 shows, on the left, the brick arch, and, on the right, the rubble-stone arch, the latter with a portion of the test load upon it. Fig. 5 shows the concrete arch ready for the application of a load, with the apparatus for measuring the deformation, while Fig. 6 shows the Monier arch under test, with a portion of the iron arch under construction in the foreground.

Although the curves upon which the arches were constructed were arcs of circles, yet for so flat arches the circular arc differs so little from the equilibrium curve for uniform loading that the latter occupied practically the middle of the arch ring. The test, therefore, was made by loading one-half of the arch gradually, measuring the deflections very carefully at points along the entire curve, and watching carefully for the appearance of cracks or other symptoms of distress. This one-sided loading was intended to cause the distortion of the arch to a much greater extent than was likely to occur in practice; if the cracks appeared at the points indicated by the theory, the deductions were to be considered sustained.

The materials used were tested by sample beforehand, and the modulus of elasticity determined in each case, so that the theoretical and practical conditions could be compared.

Many ingenious and delicate devices were used for measuring the deformations of the arches at different points under increasing loads, as, under the elastic theory, the deformations should be proportional to the loads until the elastic limit is reached; the importance of exact measurements in this connection was, therefore, very great. The loads were applied at points prepared in the construction of the arches in the form of steps at equidistant points in the span, this form of loading giving a clearly-defined distribution at definite locations, and also corresponding to a satisfactory method of supporting the roadway in actual constructions.

As the method was the same for all the arches tested, an account of one will serve for all. Taking the case of the rubble-stone arch, the load of the arch itself was gradually distributed, the depth of the key being 23.6 inches and at the springings 43.3 inches, while the additional load was applied at six points equidistant from the crown to the springing. The test load was composed of rails piled upon the platforms above, and gradually allowed to descend upon the arch in determinate quantities, the measurements giving the corresponding deflections.



BRICK ARCH. FIG. 4. RUBBLE-STONE ARCH.

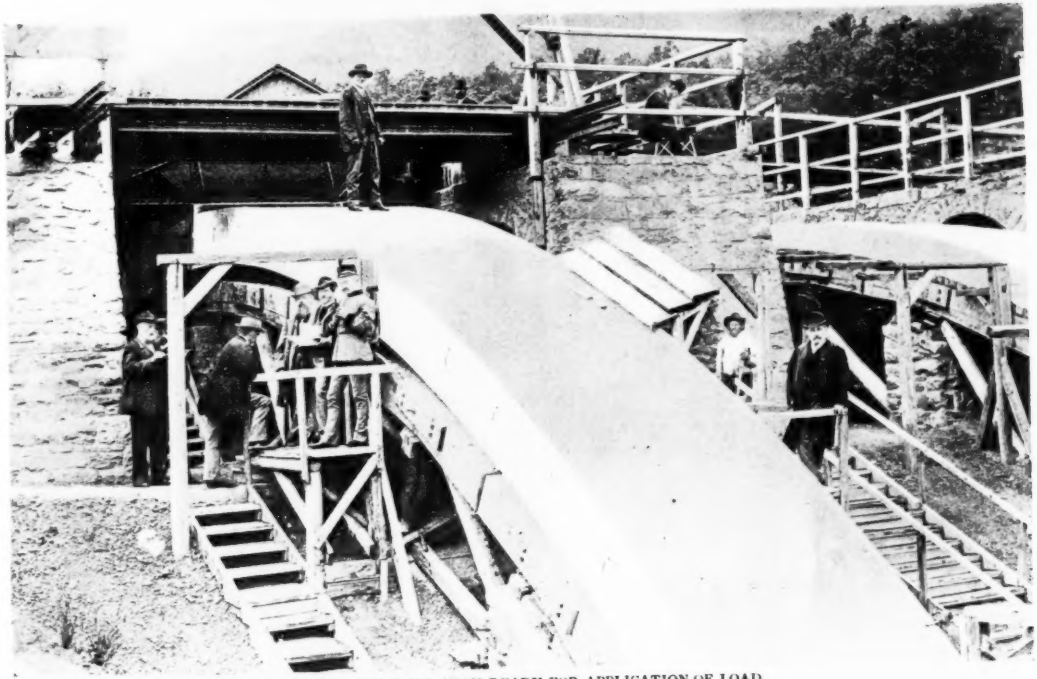


FIG. 5. CONCRETE ARCH READY FOR APPLICATION OF LOAD.

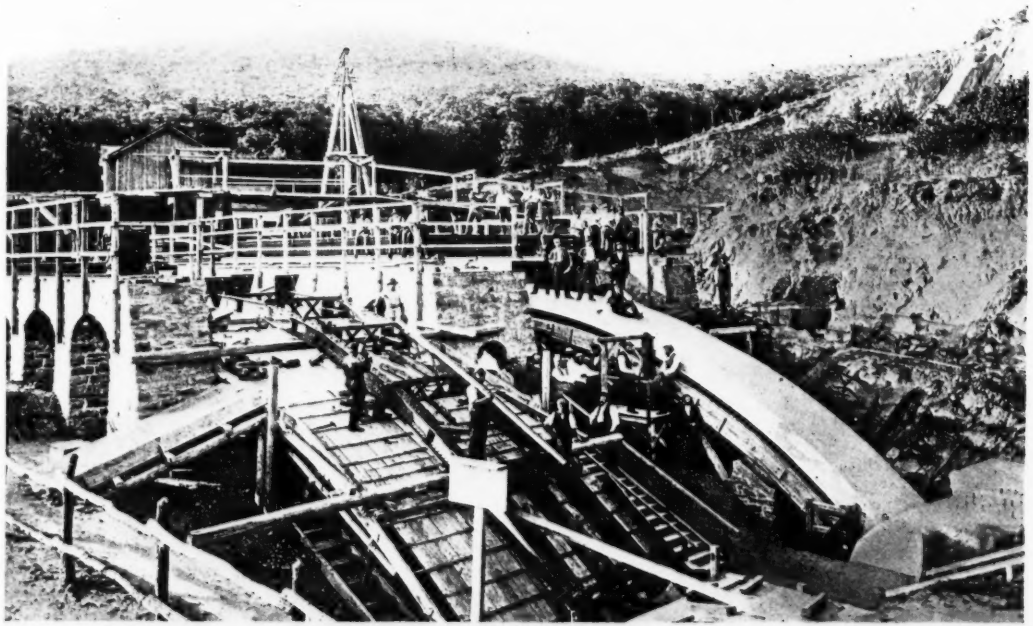


FIG. 6. MONIER ARCH UNDER TEST.

As the loads were applied, the deflections increased almost in direct proportion to the force applied, showing that the laws of elasticity

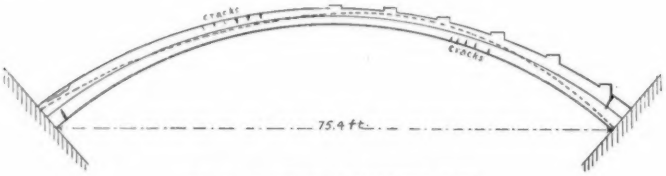


FIG. 7. FAILURE OF MASONRY ARCH.

hold good for masonry as well as for metallic structures, while, after the elastic limit was surpassed and cracks began to form, both the location of the cracks and the point of maximum deformation showed that the position of the equilibrium curve practically coincided with that demanded by the elastic theory. These facts will best be shown by an examination of the arch itself, Fig. 7. The cracks shown began to appear when the one-sided load reached about five hundred pounds per square foot, and in nearly every case they occur at those points furthest from the distorted line of pressure,—that is, at the portions under greatest tension,—and it was at these points that the arch finally failed when tested to destruction with a load of 660 pounds per square foot.

Practically similar results were obtained with the other arches, the differences in strength and distortion being only those due to the difference in material, and the theory being sustained in all cases. In the report, which was jointly prepared by the twelve members of the committee, all the data are given in detail, and the mathematical discussion is worked out in full, while graphical diagrams show clearly how the results of the tests may be applied to the design of future arches.

One of the most immediate results of these exhaustive and valuable experiments was the construction of the great arch over the Pruth at Jaremcze. This is a stone arch of 65 meters' span by 17.9 meters'

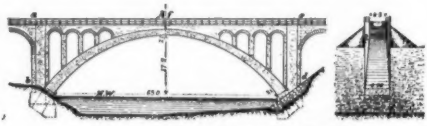


FIG. 8. ARCH OVER THE PRUTH.

rise, or 213 feet by 58.6 feet, and has, therefore, a greater span than any other railway arch in the world. The only arch exceeding it is

the Cabin John Arch near Washington of 220 feet' span, but that carries only an aqueduct and is therefore not subject to the action of moving trains. The Jaremcze arch was designed by Inspector Huss,

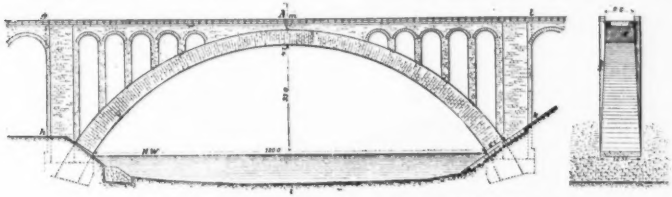


FIG. 9. PROJECTED ARCH OF 120 METERS' SPAN.

directly upon the lines indicated by the results of the tests of the committee, and in its construction the distribution of the load was effected in a manner similar to that adopted in the tests. This fine arch, completed in 1894 at a cost of about $34,000, was the first fruit of the result of the work of the committee, and it is probable that other great arches will be constructed on the same lines.

The report contains a design for a similar arch of 120 meters' span (393 feet). Both the Jaremcze arch and this proposed arch are shown in Figs. 8 and 9, and, while in some particulars the proportions differ materially from those called for by previous methods, the effect is artistically pleasing, while the strength and distribution of material are such as to conform fully to the requirements developed by the tests.

It is a matter for congratulation that the work of the Austrian Society of Engineers and Architects has practically solved the problem of the arch, and enabled both its theory and practice to be established upon a sound and fully-demonstrated basis.

CHARACTERISTIC AMERICAN METAL MINES.

THE MINES OF THE MINNESOTA IRON COMPANY.

By Horace V. Winchell.

FOURTEEN years ago Minnesota was unknown as a producer of iron ore. Last year her mines yielded about one quarter of the entire product of the United States, and her output of 3,970,000 gross tons of high-grade hematite exceeded that of any other State except Michigan. Spain, Germany, and Great Britain are the only foreign countries which mined more iron ore than Minnesota in 1896, and, when the returns are counted for the present year, both Spain and Michigan may be found in subordinate positions. This phenomenal growth is in large part due to the enterprise and good management of the Minnesota Iron Company in the development and exploitation of the rich and extensive ore deposits of the Vermilion and Mesabi iron ranges.

Organized under the laws of Minnesota November 14, 1882, this company, with a capital of $16,500,000, has so extended its interests and expanded its operations that it is to-day by far the largest producer of iron ore in existence. It also owns and operates about 154 miles of standard-gage railroad; five ore docks, equipped with 743 pockets of a capacity of 120,900 gross tons of iron ore; and nine steel steamers and five barges with a combined capacity of about 50,000 tons. The railroad is operated by the Duluth and Iron Range Railroad Company, and the vessels by the Minnesota Steamship Company.

The seven mines owned by this giant iron ore concern are situated at Ely and Soudan on the Vermilion range, and at Biwabik, Sparta, Eveleth, and Virginia on the Mesabi range. The docks, as well as the shops and round-house, of the railroad company are at Two Harbors, on the north shore of Lake Superior, at a distance of from 57 to 86 miles from the mines.

The railroad was built from Two Harbors to Soudan (67 miles), and the iron mines were opened at the latter place in 1883 by Charlemagne Tower, of Philadelphia, father of our present minister to Austria. The present company acquired possession about three years later.

The names of the mines owned and operated by the Minnesota Iron Company are: the Chandler at Ely, the Minnesota at Soudan near Tower, the Canton at Biwabik, the Genoa at Sparta, the Fayal

FIG. 1.—Map of the Iron Ranges of Northern Minnesota.

and Auburn near Eveleth, and the Norman at Virginia,—all in Saint Louis county, Minnesota.

The Minnesota mines, at Soudan, which were the first iron mines opened in the State, produce a hard and massive hematite ore, which, after being mined, is passed through powerful crushers to reduce it to convenient size; the Chandler mine produces a naturally crushed or granular hard ore; and the Mesabi mines yield soft ores of varying chemical and mechanical qualities. The Minnesota Iron Company

MINNESOTA MINE AT SOUDAN. VIEW OF NO. 8 OPEN PIT AND SHAFT, LOOKING WEST.

is thus enabled to meet almost any requirements, and can supply ore adapted to the manufacture of any grade of iron and steel.

The average analyses of its different ores shipped during 1896 are as follows:

VERMILION RANGE.

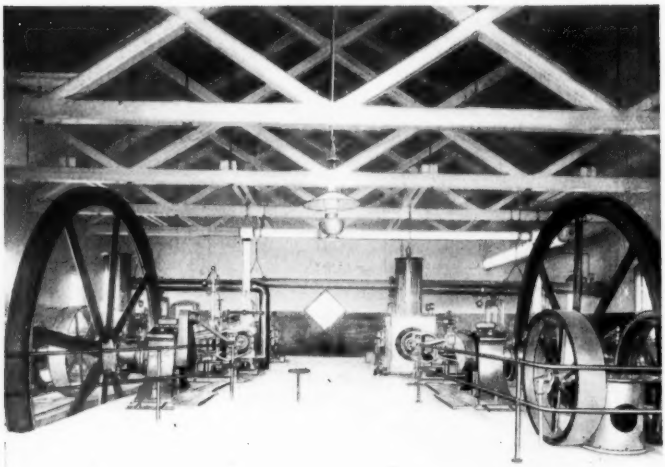
Name of Mine.	Name of Grade.	Iron.	Silica.	Phos.	Mang.	Sulph.	Alum.	Lime.	Magn.	Moist.
Chandler	Chandler	64.70	4.26	.036	0.13	trace	1.37	.33	.10	5.79
"	Long Lake	60.59	7.80	.040	0.13	.004	1.85	.72	.20	7.55
Minnesota	Minnesota	67.74	1.55	.048	none	none	.90	.27	.12	2 00
"	Soudan	65.31	4.36	.104	none	trace	.68	.62	.28	.....
"	Red Lake	64.41	3.74	.108	none	trace	1.81	.35	.11	.....
"	Vermilion	67.36	1.68	.156	none	none	.62	.60	.25	.....

MESABI RANGE.

Auburn	Auburn	65.04	2.25	.047	0.39	trace	1.47	.68	.15	9.56
"	Audrey	62.69	2.64	.071	0.66	trace	1.52	.25	.14	12.07
Canton	Climax	63.64	1.94	.036	0.87	trace	.60	.88	trace	8.65
"	Canton	60.80	4.25	.048	0.49	trace	.93	.71	.07	9.97
Fayal	Fayal	62.55	3.06	.037	1.00	trace	1.30	.26	.14	9.55
Genoa	Genoa	62.70	3.75	.033	0.65	none	1.16	.60	.19	11.29
Norman	Norman	62.15	3.75	.069	0.90	trace	1.82	.52	.13	8.41
"	Saxon	64.29	3.75	.039	0.56	.....	1.21	.12	.04	8.00

MINNESOTA MINE, NO. 8 SHAFT, HOISTING AND CRUSHING PLANT.

MINNESOTA MINE, NO. 9 SHAFT AND OPEN PIT, LOOKING EAST.

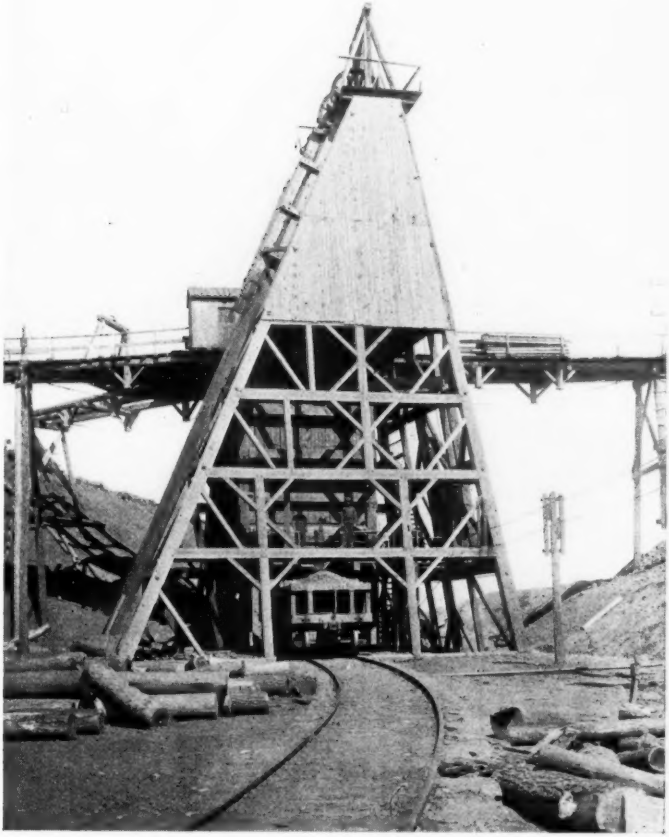


MINNESOTA MINE, INTERIOR VIEW OF COMPRESSOR HOUSE.

In the thirteen years which have elapsed since the first shipments from the Vermilion range the hard-ore mines at Soudan have produced 5,169,071 gross tons of ore; the Chandler mine has sent out 3,793,007 tons; and the Mesabi mines of the Minnesota Iron Company, the earliest known of which was discovered but five years ago and which have been shipping but three seasons, have produced 1,842,504 tons, making a total tonnage of 10,804,582 gross tons, or more than 12,000,000 net tons of iron ore handled by a concern only fifteen years of age. In an age of large enterprises the achievements of this company rank with the greatest.

The Minnesota mine comprises a number of openings in a group of hematite lenses. The enclosing country rock is green schist or slate of Keewatin or Lower Huronian age. The dip of the ore lenses is at a high angle to the north, and their strike is nearly east and west. The ore deposits are of irregular shape and of varying size and quality. Nearly half the ore mined has been of bessemer grade, and very low in sulphur.

Some differences of opinion have existed among geologists as to the origin of these Vermilion range ores, but it is now generally agreed that in their original form they were chemical oceanic precipitates or sediments. Whether they were primarily hydroxids, carbonates, or silicates, or mixtures of these, and whether deposited without or with



CHANDLER MINE, NO. 2 SHAFT AND POCKET.

the agency of organic forms, is not clearly demonstrated. The age of the rocks, and chemical considerations, lead the writer to believe that the iron and silica were chemically precipitated as hydroxids without the aid of organic life. By subsequent rearrangement and alteration the silica was removed, and the iron oxid concentrated as we now find it.

These lenses of ore are found entirely surrounded by the green

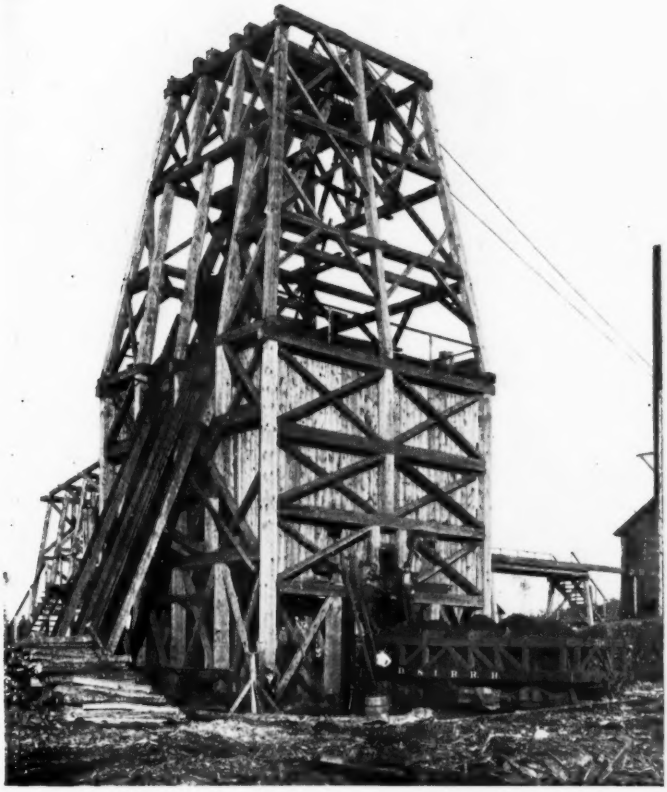
CHANDLER MINE, STOCKPILE AT NO. 4 SHAFT, CAVED GROUND TO THE LEFT.

AUBURN MINE, OPEN PIT, SHOWING CRATERS AND FIRST LEVEL DRIFTS UNCOVERED.

schists. They were first found in outcropping knolls, but lenses of good ore that did not come within five hundred feet of the surface have been discovered in the underground developments. Indeed, it is a common practice at these mines to keep boring into the walls with a diamond drill as the work progresses. By this means, when one lense is exhausted, others are frequently discovered near by. The thickness of these ore bodies varies from nothing to a hundred feet or more; their length may be several hundred, or even a thousand feet, and their vertical axis is sometimes as great as their length.

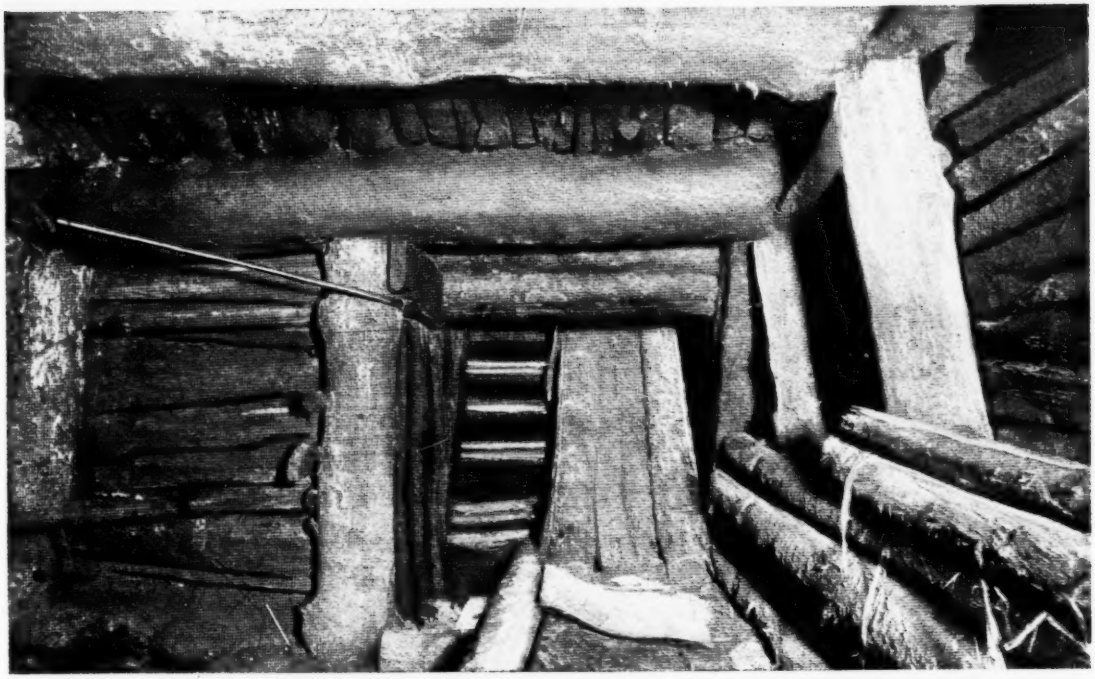
The open-pit method of working was first adopted at the Minnesota mines, but soon gave way to that now in vogue, which seems peculiarly adapted to deposits of this nature, and reflects great credit on its originator. It is called "longitudinal overhand stoping with back-filling." The ore is hard and strong, but the schist walls are weak and treacherous. Shafts are sunk in the foot wall some distance from the ore, but with approximately the same dip, and connected with it by cross-cuts at the several levels. These levels are carried from foot- to hanging-wall, and in the ore are blasted out fifteen or twenty feet high. The gang-way is then covered by timber, leaving the necessary openings for ladders and chutes. Rock is then drawn in from raises in the walls, and piled up above the protected level, until more ore can be won by overhand stoping. When about ten feet more of ore has been blasted down, the rock raise is again tapped, and the filled floor again rises so that more ore can be reached. This process is carried nearly

AUBURN MINE, SHOWING DEPTH OF STRIPPING. SHAFT APPEARS IN BACKGROUND.



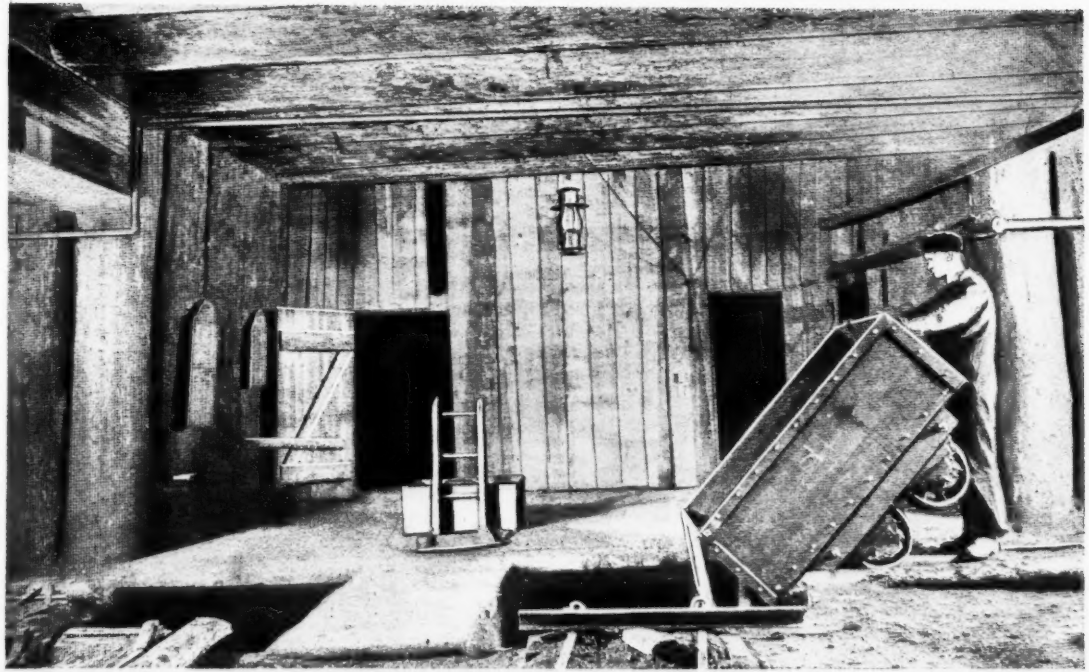
AUBURN MINE, SHAFT AND POCKET, SHOWING MANNER OF LOADING CARS FROM POCKET.

to the level above, a floor of ore being left to support the level temporarily. Diamond drills are used in drilling for back-stoping. The ore is run down into tram cars in the level below, through chutes placed thirty feet apart. Mules are used for tramming in the longer levels, and the ore is hoisted in cages. In the cars in which it is brought to the surface the ore is then run on tracks to the crusher house. Here it is passed through jaws of manganese steel, and thence

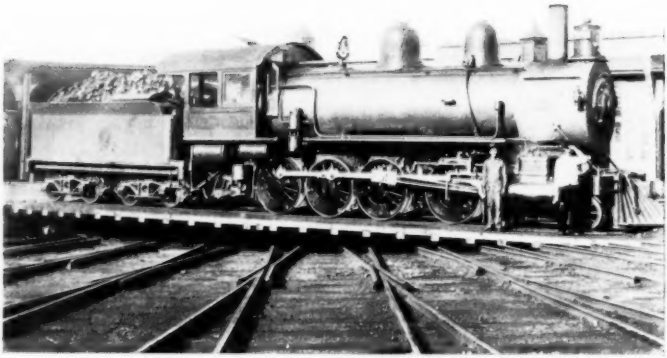


FAYAL MINE, BOTTOM OF A TIMBER SLIDE.

[F. W. Denton, Trans. Am. Inst. Min. Eng.]



FAYAL MINE, UNDERGROUND VIEW, LOOKING TOWARD THE SHAFT AND SHOWING THE OPENINGS INTO THE POCKETS.
[F. W. Denton, Trans. Am. Inst. Min. Eng.]



123-TON LOCOMOTIVE, DULUTH AND IRON RANGE R. R.

conveyed to pockets for loading into cars, or to the stockpile. All the ore mined during the winter is stockpiled until spring, and loaded on ore cars by steam shovel during the season of navigation. The average output from this mine has exceeded 425,000 tons per annum, or about 1,350 tons per diem for the past twelve years. It is now apparently in better condition than ever.

The Chandler is the other great Vermilion range mine of the Minnesota Iron Company. Covering but eighty acres, and with half as many shafts and a much smaller force of miners, this mine has produced about 1,500 gross tons per day for the past eight years. The reason for this greater output lies in the fact that the ore is naturally crushed, requiring less drilling and blasting. Moreover, it can be worked by the caving system. In 1896 this mine produced 471,545 tons of ore, every pound of which was of bessemer quality, and seven-eighths of which averaged more than 64.5 per cent. of metallic iron.

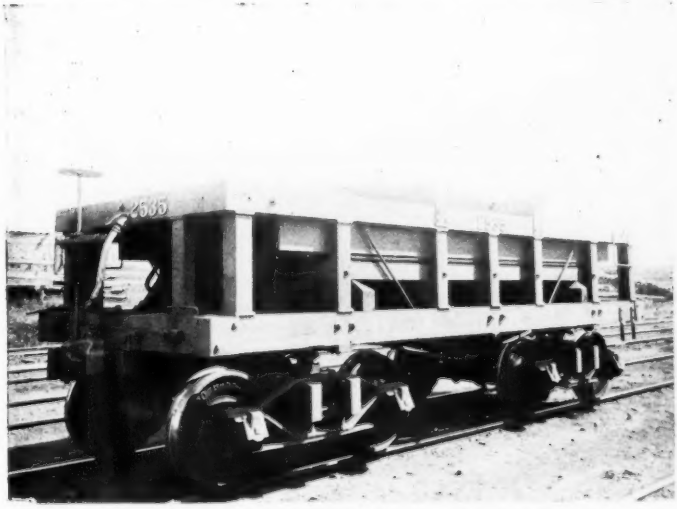
Mining here is carried on through shafts in the walls and by a series of main and sub-drifts. With the development and equipment which this mine now has, it can easily produce 70,000 tons of ore per month. Because of its uniform grade this ore is in much demand by furnace men, and many Lake Superior cost records have been lowered

by reason of the steadiness and economy with which the mine has been operated.

The first mine to be opened on the Mesabi range by the Minnesota Iron Company was the Canton near Biwabik. This was in 1892. Since then the Norman, Auburn, Fayal, and Genoa mines have been successively purchased and developed.

The origin of the Mesabi ore is due to the alteration of a rock called "taconite," and its concentration by the action of atmospheric waters in the oxidation of the iron-bearing mineral, and the removal of the commingled silica. This taconite is believed to have been deposited in the waters of the Taconic or Upper Huronian ocean, largely through the agency of foraminifera and the formation of green sand or glauconite. There is a marked contrast between the ores of the Vermilion and Mesabi ranges. That of the former range is in vertical lenses of hard ore; that of the Mesabi is in almost flat beds of fine-grained "soft" ore. Both are high-grade hematite.

The mining problems that have presented themselves on the Mesabi, as distinguished from other soft-ore mines, are those which arise from the flat dip and great area of the deposits, and from the fact that the roof is glacial drift, composed of sand, clay, and boulders instead of solid rock. Owing to the variable thickness of the ore and its covering, (each ranging from 10 to 200 feet or more) as well as to its



DULUTH AND IRON RANGE ORE CAR, CAPACITY 25 TONS.

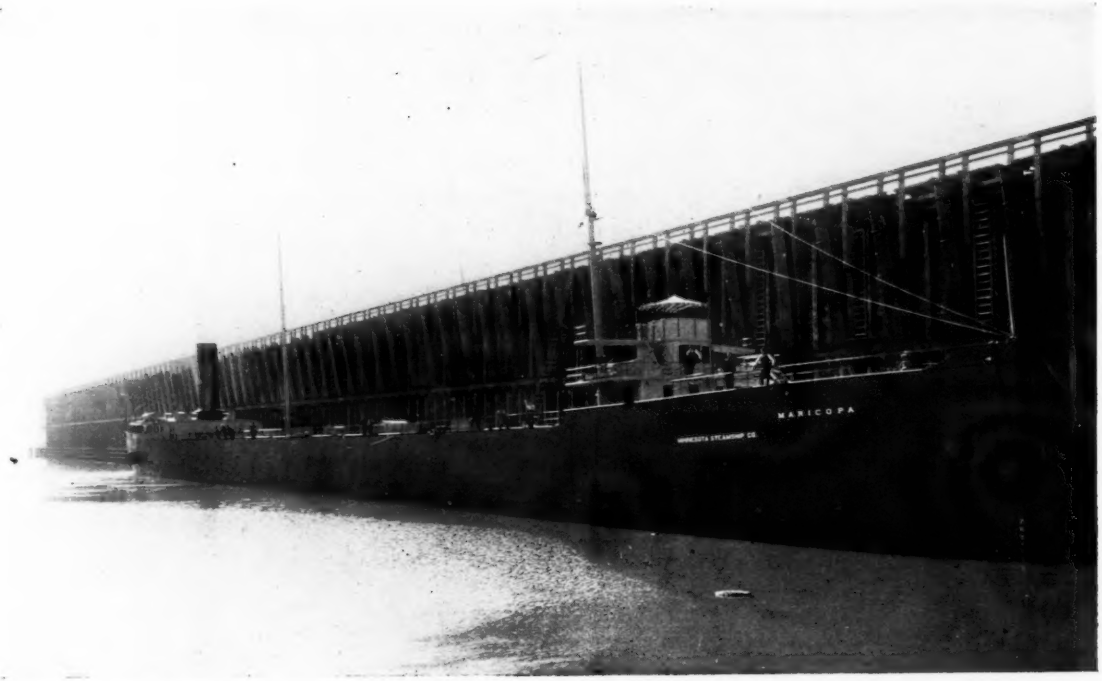
ORE TRAINS IN YARD AT TWO HARBORS, MINNESOTA.

TOP VIEW OF ORE DOCKS, SHOWING POCKETS AND METHOD OF UNLOADING ORE TRAINS.

varying quality and the irregular shape of the lenses, there have been many more or less novel methods of mining proposed. The removal of the glacial drift which covers the ore, or "stripping," by steam shovels, is the common method where the ore body is not too deeply buried, and when it possesses sufficient depth and area to warrant the large initial expenditure. It is now considered advisable to strip where the ore is three times as thick as the covering. About one-half the Mesabi output for 1896 was from open-pit mines, and the percentage will be larger for the present year.

There are two methods of excavating the ore and placing it on the car: (1) the "milling"; (2) the steam shovel method. In the former method shafts are sunk near the boundary of the ore deposit. From these shafts levels are driven at any desired depth into or under the stripped ore. Timbered drifts are then run into the ore from the main levels. From these drifts raises are put up to the surface, and the ore is milled down into them by workmen on top. Tram cars hauled by mules or by men convey the ore from these raises to the shafts, where it is hoisted in skips to the surface. In the steam-shovel method railroad trains are run upon tracks laid on the uncovered ore, and the cars are filled by steam shovels, which load the soft hematite directly from its natural bed.

Of the mines owned by this company on the Mesabi, the Canton,



THE MARICOPA LYING AT AN ORE DOCK, TWO HARBORS.

VESSELS LOADING AT TWO HARBORS DOCKS.

D. AND I. R. R. R. DOCKS, SHOPS, AND ROUND HOUSE AT TWO HARBORS, MINNESOTA.

Fayal, and Genoa are regular underground mines, while the Norman and Auburn are operated by the stripping and milling process.

The output per man employed is very much greater in the milling system than in any other in which the ore is moved chiefly by manual labor. Thus, while from four to six tons per day for each man employed is a satisfactory output for underground mines, it is nothing unusual for the production at milling mines to average forty tons per day for all men above and below ground, and twice this amount has been mined for short periods under favorable conditions. The scene at the Auburn mine is quite picturesque. The open pit in which the ore is being milled presents the appearance of some volcanic crater, while the men engaged in shovelling and sliding the ore down into the apparently insatiable holes in the ground look like imps of the devil feeding the internal fires. The white smoke which emerges from the dark ore after a blast completes the illusion. The Auburn is the finest example of a milling mine on the Mesabi, and is well worth visiting.

The Fayal mine is already one of the largest and most completely developed in the Lake Superior region. A producer for only two years, and that mainly of ore taken out in development work, it is a good example of what money and brains can accomplish in a short time on the Mesabi range. Miles of underground levels and drifts, all arranged with a view to maximum output at minimum cost, lead the visitor past millions of tons of ore all ready for mining. Ingenious and labor-saving devices and methods abound on every hand, and the plan of the mine is as nearly perfect as study and experience can make it. The future of such mines as these may certainly be regarded with complacency by their owners.

The limits of this article will not permit particular mention of all the Mesabi mines of the Minnesota Iron Company. It is sufficient to repeat the remark made to the writer by the editor of a prominent eastern iron journal while travelling through the district recently: "You may know a mine of the Minnesota Iron Company at a glance by the air of systematic and thorough neatness and order apparent on every side." Certainly the writer has never seen finer or more efficient mining plants. Probably one reason for the general tone of its affairs is the good judgment displayed by the Minnesota Iron Company in the choice of superintendents and foremen. The fact also that considerable latitude is given to these men in exercising their individual tastes and displaying their ingenuity and originality may have something to do with it. Still, there must be something back of all this, and it probably lies in the strong personality of those responsible for the general management.

The Duluth and Iron Range railroad, under the direction of Mr. J.

L. Greatsinger, is as efficiently and systematically operated as the iron mines. A standard-gage mining railroad is perhaps common enough. But to find one with 154 miles of main line and 60 more of side tracks, laid with 80-pound rails, owning some of the finest rolling-stock ever built, consisting of 58 locomotives (12 of which are 12-wheel locomotives weighing 123 tons each), 2,298 ore cars, 434 box, flat, and other freight cars, and 14 passenger and express coaches, is certainly worthy of special comment. These cars and locomotives are kept busy during the season of lake navigation, as will be seen from the following statement of the business done in 1895:

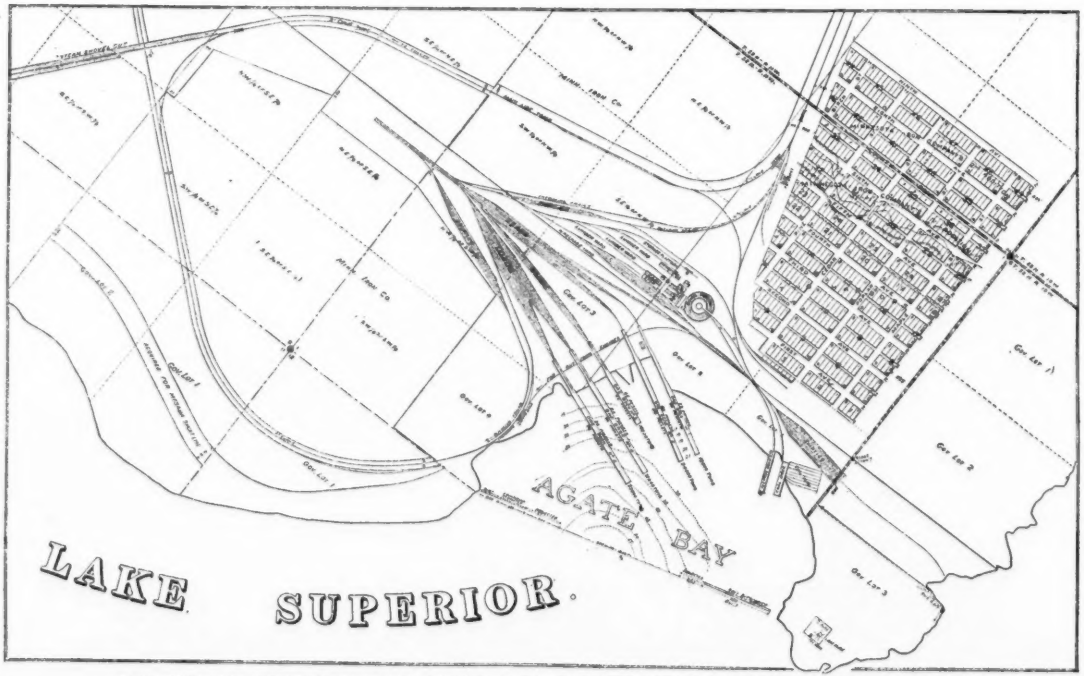
Passenger earnings	.....	$ 69,258.01
Freight "	.....	1,488,337.44
Mail "	.....	7,218.72
Express "	.....	6,000.00
Miscellaneous "	.....	5,453.02
Total [$9,592.66 per mile]	.....	$1,576,267.19

The business done in 1896 was considerably in excess of that of 1895, and this season is thus far ahead of any former year.

All ore cars are built with hopper bottoms for dropping the ore into the pockets of the docks. The latter are from 45 to 54 feet above the water, and the ore slides from the pockets through iron chutes into the holds of the vessels. The speed with which vessels are loaded and unloaded is little short of marvelous. Vessels frequently load and depart with a cargo of 3,500 or 4,000 tons within two hours from the time they reach port. One record has been made of 2,350 tons of ore loaded in forty-five minutes. From 15,000 to 40,000 tons of ore are handled daily at Two Harbors with a force of men that at first sight seems totally inadequate. The design of the yard and the approach to the ore docks at Two Harbors is said to be a remarkably fine example of railroad construction, and in the handling of large and irregular volumes of traffic this little iron ore road sets an example that could be studied with profit by more than one trunk line.

From Two Harbors to Cleveland, the principal iron-ore market of the central west, the distance is about 800 miles. For carrying their ore to Lake Erie ports the Minnesota Iron Company, through its associated corporation, the Minnesota Steamship Company, owns a fleet of nine steel steamers and five barges. The names of these vessels and their carrying capacity in gross tons on a draft of fifteen and a half or sixteen feet of water are as follows:

Marisca, Manola, and Maruba, about 2,500 tons each; Masaba and Marina, about 2,700 tons each; Mariposa and Maritana, 3,400 to 3,500 tons; Maricopa, 4,500 tons. The barges are: Marcia and



TERMINALS AND DOCK YARDS OF THE DULUTH AND IRON RANGE RAILROAD AT TWO HARBORS, MINNESOTA.

Malta, each carrying 4,000 tons, and the Martha, Manda, and Magna, each carrying 4,500 tons.

The combined capacity of the fleet is thus nearly 50,000 tons per trip, or slightly less than a million tons during the season. At the average season rates for the past ten years ($1.16) this fleet is capable of earning more than a million dollars per annum on eastward-bound freight alone. With deeper water between lakes Superior and Huron the size of the cargoes can be materially increased.

There are many interesting features connected with the general scheme of operations of this company. As already stated, order is the watchword in every department. At the warehouses of the different mines, for example, an exact account is kept of the disposition of every article, no matter how small or inexpensive. Each miner is charged with every candle or implement that he removes. Where so many are employed, little losses would soon aggregate a great deal.

Sick or disabled miners are cared for in the hospital of the company by the company physician. For this privilege each man pays one dollar per month, and is treated free of any other charge as often as may be necessary, with hospital privilege for six months in case of injury.

There is also a benefit fund, to which each man contributes forty cents per month, and the company adds an equal amount for each laborer on the pay-roll. In case of injury a single man receives $15 and a married man $20 per month for six months, if the injury lasts so long. In case of death, $500 is paid to the heirs.

A large number of comfortable houses have been built at Soudan by the company. These are rented at a low rate to the employees. On some occasions during the past four years, when there has not been work for all the men, they have been permitted to occupy these houses rent-free, and also been allowed to cut firewood, free of charge, on lands belonging to the company.

Educational matters are carefully looked after among the mining communities, and a large school house was built and equipped by the company at Soudan. The salaries of three and a half teachers are also paid from the regular monthly pay-roll of the company.

No stores or saloons are allowed at Soudan. They are all located at Tower, some two miles distant. Delivery wagons from the latter place take orders and deliver goods daily at the mining location. At Ely and on the Mesabi range, where other mining companies are interested, and the land has a variety of owners, it is impossible to arrange matters as they are arranged at Tower and Soudan. Liberal provision is usually made, however, regarding school and hospital matters at all the mines, and at Two Harbors for the railroad employees.

The number of employees of the company in its mining operations alone is about 2,400 at the present time. It varies from 1,200 to 3,000. The miners are chiefly Austrians and Finlanders. The latter are considered the more intelligent. The only strike that the Minnesota Iron Company has ever had was caused by a difference of opinion over the observance of an optional Roman Catholic holiday. That strike lasted but two and a half days. There has never been any trouble over wages or hours of labor.

Offices of this company are maintained at New York, Cleveland, Chicago, Duluth, and Soudan. The president and general manager, Mr. D. H. Bacon, resides at Tower. To him more than to any individual is due the wonderful success of the Minnesota Iron Company, and it is generally admitted among those familiar with this industry that he is without an equal as a manager and organizer, as well as in his complete familiarity with the iron-ore business.

Possessed of seven magnificent iron mines, and owners of a complete line of transportation to carry its ore to market, this company is to-day able to force its way into the ore market, and hold its share of business against any competitors. It has already, July 1, sold 1,882,000 tons of ore for this year's delivery, and its mines will probably produce a total of 2,200,000 tons. Their producing capacity is not less than three million tons, and the railroad and docks can handle three and a half millions.

If the demand for iron continues to increase, we may soon have one company up in the North Star State producing as much iron ore as all the mines of Spain, or even of Germany.

ISOLATED ELECTRIC PLANTS VERSUS CENTRAL STATIONS.

By Percival Robert Moses.

II.

IN the two groups already described, power for elevators is a small factor of the total required for all the purposes of the building.

In the office-building, on the contrary, the power required for elevators is frequently greater than that needed for all other purposes. The heating requirements are severe only while the tenants are occupying their offices. As more steam is needed for heating than would be used for lighting the building, the coal bills in winter are not increased by the demand for light; but, in summer, the production of light requires some additional coal. It is these factors, with their requirements of skilled labor, that enables the isolated plant to completely control the situation in all office-buildings constructed at the present time. In few of the examples cited would the abolition of the lighting plant reduce the annual expenditure for labor by more than the wages of a fireman.

The central-station supply has a field in many of these buildings in supplying light and power during the hours of partial operation. Buildings similar in character (see tables) containing electric elevators have a fuel-consumption slightly less than that of those containing hydraulic machines. This is to be expected, on account of the partial conformity of the power required to the load raised in the electric machine, and the absence of such regulation with the hydraulic machine.

Compare Nos. 1 and 2. These buildings are adjoining and well-situated, and they cater to the same class of tenants. No. 1 does not include light in the rent; No. 2 does. No. 1 runs 10 hours; No. 2, 12 hours. No. 1 has two steam elevators; No. 2, one high-speed hydraulic elevator. The total extra cost imposed on No. 2 in order to give "free electric light" is about $1,300 a year, $150 for fuel, $480 for labor, and $600 for interest (5 per cent.) and depreciation (10 per cent). There is a floor area of about 50,000 square feet available for renting, so that the rents would have to be raised 2.6 cents a square foot per year to pay for the plant operation. At this rate an office 20×20 would be assessed less than a dollar a month.

Compare, next, Nos. 3 and 4. These are more nearly alike in available floor space than their dimensions indicate. No. 4 has a

TABLE III.—GROUP III.

No.	Character Building.	Dimensions. H.	W.	L.	Stories.	Total Lights.	Average Load.	Est'm'd cost Plant.	Fuel, cost per day	Elevators. E S H	Speed	Plant Operation, cost per year.	Items Included in Rent	Labor. Eng	Firemen	Others	Hours Service	Heating System.	Coal Used.	Total Annual Oper'g Cost
1	Office (Old)	85	75	175	7	500 (Est.) Gas	——	——	4.50	— 2. —	Slow	2300.00	Heat, etc.	1	—	—	10	Reduced Direct Press	Furn'ce	2300.00
2	Office (Old)	85	50 25	125 125	7	500	300	2800	4.85	— — 1.	Fast	3000.00	Heat, Light, etc.	1	1	—	12	Exhaust and Live	Pea	3000 00
3	Office (New)	120	60	45	10	800	300	3000	3.25	— — 2.	Fast	3300.00	Heat, Light, etc.	1	1	1	10	Exhaust	Pea	3300.00
4	Office (Old)	80	75	100	6	600	200	——	5.25	— — 2	Slow	(P) 3100.00 (L) 2400.00	Heat, Light, etc.	1	1	—	10	Reduced Direct Press.	Furn'ce	5500.00
5	Office (New)	150	50	40	13	800	250	4000	2.85	2. — —	Medium	3000.00	Heat, Light, etc.	1	2	—	12	Exhaust	Pea	3000 00
6	Office (New)	150	60	50	13	800 (Est)	75	——	3 75	2. — —	Fast	(P) 3000 00 (L) 2500 00	Heat, etc. Light in Private Offices.	1	1	1	12	Exhaust	Pea	5500.00
7	Office and Newspaper	125	100	110	10		900	5000	30.00	— 1. 2	Fast	16000 00	Heat Light, Steam for Presses.	3	3	—	24	Exhaust	Pea	16000 00
8	Office and Telegph.	225	80	150	14	3000	1000	14000	26 00	6. — —	Fast	28000.00	Heat, Light, etc.	4	6	7	24	Exhaust	Furn'ce	28000.00
9	Office	180	80	110	15	1000	300	12000	9 00	5. — —	Fast	8000.00	Heat, Light, etc.	3	2	—	10 full	Exhaust	Pea	8000 00
10	Office	150	50	125	13	1200	300	5000	7.50	— — 3	Fast	5800 00	Heat, Light, etc.	3	1	—	10(f) 7(p)	Exhaust	Buck-wheat	6000.00
11	Office	150	40	120	12	1400	——	7000	5.00	— — 3.	Fast	5300.00	Heat, Light, etc.	2	2	1	12(f) 12(p	Exhaust	——	5300.00

TABLE IV.—GROUPS IV AND V.

No.	Character Bl'ding	Dimensions. H.	W	L.	Stories.	Total Lights.	Average Load.	Fuel, cost per day	Est. cost Light. Plant	Elevators. E. S H.	Plant Operation, cost per year.	Ice Supply.	Character of Business.	Labor. Eng	Firemen	Others	Hours Service	Heating System.	Coal Used.	Total Annual Oper'g Cost.
1	Club	60	75	75	3	900	?	4.25	3000	——	35000 00	Company	Social	2	1	—	24	Exhaust	Pea	3500.00
2	Restaurant	60	25	150	3	250	150	——	——	——	(P) 550.00 (L) 2000 00 (H) 700.00 (I) 1200.00	Company	High-class Restaurant	1	—	—	18	Direct	——	4450.00
3	"	50	150	100	3	750	60 (D) 350 (N)	5 25	4000	——	(P) 4000.00 (I) 1200 00	Company	"	2	1	—	24	Exhaust	Pea	5200 00
4	"	50	50	100	3	500	60 (D) 450 (N)	4.50	——	——	(P) 3000 00 (L) 5000.00	Machine	"	2	—	—	20	Exhaust and Live	Pea	8000 00
5	Store	60	150	175	4	100 inc. 6 arcs 250 gas	——	6.00	——	1. 1. 1.	(P) 2500 00 (L) 1800.00	——	Dry Goods	1	—	—	10	Direct LowPres.	Broken	4300.00
6	"	90	90	80	7	450 inc.	——	Excess 0.80	3700	— 2. —	(Excess) (P) 1025 00 (L) 240 00	——	Wholesale and Retail DrugHouse	1	1	—	12 (full)	——	Broken	Excess 1253.00
7	Loft	75	25	50	6	——	——	1.00	——	1 — —	(P) 375.00 (L) 180.00	——	Various	—	—	—	10	Direct	Pea	555.00
8	"	75	40	75	6	125	90	2.50	1500	— 1. —	800 00	——	Commission	—	—	—	10	Direct	——	800 00
9	"	100	100	125	9	1200	400 (D)	8.64	6000	— — 6.	7000.00	——	Wholesale Dealers	3	1	—	15	Exhaust	Broken	7000.00

large restaurant, the cost of lighting which was formerly included in the rent. No. 3 has an insurance company requiring a large quantity of light. Otherwise the conditions are similar. No. 4 uses expensive pea coal and wasteful old-type elevator pumps and boilers; No. 3 uses three-watt lamps, high-speed modern hydraulic elevators, and new boilers. No. 4 obtains light from a central station; No. 3 has a private plant. No. 4 heats with steam at reduced pressure; No. 3 uses exhaust steam entirely. Labor in No. 3 costs about $850 a year more than that in No. 4. On the other hand, coal in No. 4 costs $600 a year more than that in No. 3.

By the use of modern machinery and exhaust heating the plant of No. 3, including lighting, is operated at a cost exceeding by $250 a year that of operating the plant of No. 4, excluding lighting. No. 4 gives free light, and, although well situated, is half empty; under present arrangements, the restaurant pays for its own lighting, and has had its rent reduced. The bills for lighting averaged more than $200 a month with the building filled, showing a gain for No. 3, exclusive of interest and depreciation, of $2,150 a year. Deducting the fixed charges, at 15 per cent. on the cost of the generating plant, the net gain shown amounts to $1,000 a year,—enough to pay for the plant in two years.

Nos. 5 and 6 can also be compared. The latter is about to install a lighting plant, but the present conditions will serve. The buildings are about the same size, each having two elevators. No. 5 gives free light throughout; No. 6 supplies offices, but not the stores or the club (at present), with a consequent loss of rental. In No. 5 the elevators and lights are supplied from the same generating set, except at periods of large lighting-load; No. 6 has both its elevators and lights on the central service. Both buildings are exposed, and have a large heating factor. The cost of operation of the two plants is the same, and, in addition, No. 6 pays $2,500 a year for light and power, and also a portion of the rent.

No. 7 is interesting; it is a newspaper building, with an old high-pressure heating plant remodeled, large engines intended for 12 pounds, back pressure, etc., two hydraulic high-speed elevators, and one steam drum elevator. It has a day load of 500 lights and a night load of 1,000. Boilers supply steam for the presses of two newspapers, and light for one. Ten tons' pea coal, costing from $2.85 to $3.00 a ton, are used per day. One chief engineer, two assistants, and three firemen are employed. The total operating cost of the engine room and plant, everything included, is less than fifty dollars per day. The lighting of this building was placed on the central-station service as a test of comparative economy and at the rates then prevailing,

$0.006 per lamp hour. The lighting alone cost more than the entire operation of the plant at present.

Throwing the lighting on the central service saved nothing in the cost of the labor, and but a very small portion of the cost of the fuel.

No. 8 shows the effect on operating cost of varying conditions. It is a telegraph building, and requires continuous, arduous service. The labor charge is enormous, due to the skilled labor required, and the coal bill becomes of small (comparative) account. The removal of the lighting plant would reduce the force employed by two men only and the coal bill by less than one-half, while the cost from the central service would amount to more than $25,000 per year.

No. 9 is an example of a building in which the power for elevators is greater than that required for the rest of the equipment. It has fifteen stories and contains more than three hundred separate offices, requiring little artificial light and considerable heating. There are five elevators, whose average speed is more than 400 feet a minute. The total coal-consumption is less than three tons of pea coal per day, and the average current used during the ten hours of full service is 300 amperes. At one cent per ampere-hour for both light and power this service would cost about $9,000 a year, or $1,000 more than the present total operating cost. The removal of this isolated plant would decrease the annual labor charge $1,000, and the coal bill one-third, or $900, adding $2,100 a year for interest, depreciation, and taxes; the total annual reduction would be $4,000,—a loss to the owners of $5,000 a year. While this coal charge is small, it will be lowered by the employment of an auxiliary storage battery for regulation and to supply the night load. It is the intention of the owners to install such a battery, and to remove the present connection with the central station which supplies the night requirements,—one elevator with infrequent service and a dozen lights,—at a monthly charge of fifty dollars.

To arrive at a fair estimate of the value of a storage-battery adjunct compare No 11, which contains such a battery, with No. 10. Each has three hydraulic high-speed elevators and an approximately equal floor space. The labor does not enter as a factor in the comparison, as it is not varied by the presence of the auxiliary battery. The difference shown is due to local conditions. The fuel-consumption in No. 11 is two-thirds of that of No. 10,—a difference of $750 a year. The installation was justifiable, provided the cost was less than $4,500. No. 11 is not a building best fitted for a storage battery, as the hydraulic elevators require a double shift of labor and continuous operation of the plant,—reducing the possible economy to the fuel alone. In No. 9, containing electric elevators, the difference in operating costs would

be increased by the amount of the central-station charge and decreased depreciation of machinery. In addition, the regulating property of the battery permits the operation of the generators at or near their full load, and reduces the number of units required by one third. The cost of a suitable battery and appliances for No. 9 is $5,500, and the value of the generating set displaced $3,000, making the total investment $2,500. The annual depreciation will not exceed 10 per cent. or $400. The saving in coal consumption will be about one-third, or $900, less the coal used in recharging the batteries,—cost $180; the cost of the central-station service adds $600—a total return of $920 a year, or 37 per cent. on the investment.

Groups IV and V do not allow of any definite conclusions; each case requires special consideration. In general the central-station supply is advantageous where the maximum load is comparatively large and of short duration, as in loft-buildings, stores, private houses, and small restaurants. The reverse is true where the load is continuous and equivalent to 70 lights burning 10 hours per day. Under such conditions an isolated plant can be installed to compete successfully with the central station, but the plant must be designed to meet the requirements. Other considerations, as in apartment-houses, frequently decide the question; for example, divided leasehold, lack of space for plant, presence of combustible material, lack of proper means of ridding the engine room of smoke and hot air, uncertainty of tenure, etc., overrule any possible economical advantages.

No. 1 is a social club frequented by the best class of people. The plant was designed to meet the requirements, and the results have been eminently satisfactory—to the club at least. Previous to the installation of the plant, the current for the lights was supplied by a central station. The cost of this supply was one thousand dollars a year more than the total expense of operating the present heating and lighting and elevator plant—everything included. The charge necessitated by the introduction of the lighting plant was confined to an increase of the labor cost by $45 a month and the coal bill by a small amount, the heating being accomplished by exhaust instead of by live steam. The boilers previously in use remained. The club is one of moderate size, and is representative of others.

Nos. 2, 3, and 4 are restaurants, all successful, differing from each other in details. Nos. 3 and 4 are comparable, though the latter has about one-quarter the floor space covered by the former. No. 3 contains a lighting and heating plant; the ice is purchased. No. 4 has a heating and refrigerating plant, and buys the light used. The proprietor of No. 3 expects to install a refrigerating plant in the near future, and thereby economize in the general operation of the restau-

rant. Each establishment has large display signs containing more than two hundred lamps (eight c. p.), and is well lighted inside.

No. 4 has a smaller number of lights, but uses them more profusely. As will be seen in table IV, No. 3 employs one fireman extra, and the coal costs seventy-five cents a day more than in No. 4. The coal used for the ice machine in No. 4 costs less than one dollar a day. Combining these figures, we see that the addition of an electric-lighting plant to No. 4 would not cost more than $1.25 a day for labor and $1.75 for fuel,—that is, $3.00 a day, or $1,100 a year. The interest and depreciation would be $375. The present bills for light approximate $5,000 a year. This indicates a possible saving of about $3,500 a year in the yearly cost of operating No. 4. This is less than the amount that has been saved in No. 3 each year since the installation of the plant.

No. 5 pays from thirty to forty-five dollars a month for its one electric elevator; its bills for light average more than $115 a month, or a total of $1,800 a year for both services. The extra labor required for a lighting plant, in addition to the present heating plant, is that of a helper at a dollar a day. No more coal would be required in the winter than at present. In summer very little lighting is necessary, and a quarter of a ton a day would be a large allowance, adding one dollar per day for interest and depreciation. The total cost of operating the lighting plant is $3.00 a day,—a net gain to the establishment of $900.

No. 6 is a large wholesale drug store, with a storage-battery auxiliary. Previous to the installation of the plant, the old building, four-fifths the size of the new one, was lighted first by a gas company, and afterward by an electric light company. The monthly bills varied from more than $100 in summer to $200 in winter,—average, $150, —a total of $1,800 per year, making, for this rate, $2,250 a year. With the installation of an isolated plant (cost, $3,700), the labor charge was increased $728 and the fuel charge $320; the gas bills were reduced to $240 a year. The total annual expenditure was $1,288. Adding 10 per cent. of cost of plant for depreciation,—*i. e.*, $370,—the annual cost of the light is $1,658. The difference ($592) between this sum and $2,250 is exactly sixteen per cent. on the original investment. The economy due to the storage battery in this instance proceeds from the long hours required in the retail department and the small number of lights necessary there. A point of especial moment in this connection is the fact that increasing the hours of burning adds to the total only by increasing the coal bill; that is, doubling the hours of lighting increases lighting-cost only one third.

No. 7 is a very prevalent type of building, and shows clearly one

central-station position that is unassailable, unless by a combination of many adjoining houses. In it the elevator is run from a central-station service, and the lights are paid for directly by the tenants. The elevator boy (who is to be required in New York to have a license as fireman) runs the heating plant (low-pressure boiler) in winter, and also attends the elevator. In larger buildings of this type an engineer-fireman is sometimes employed. The cost of the power for operating the elevator is $10 to $45 a month, and, together with the cost of the coal used in winter and the wages of the elevator boy, constitutes the total operating expense. In many of the larger buildings the whole plant is controlled by the tenants. In such cases the isolated plant may prove advisable, if proper arrangements can be made for division of the cost.

No. 8 is a commission house previously supplied by a central station, but at present using a gas engine belted to dynamo and belt screw elevator. The elevator man cares for the engine without extra pay. The cost of gas and sundries used is $2.60 per day (see table). The interest and depreciation on the machinery (5 per cent. and 10 per cent.) amount to seventy-five cents a day more. Total, $3.35 per day. The lights are required continually. The cost from the central station was nearly $5 a day for illumination alone. An elevator similar to the one used costs elsewhere twelve dollars a month for power. Hence the power and light equivalent to that furnished by the gas engine would have cost monthly more than $140 in contrast to $87. The saving produced paid for the plant in less than three years.

Before concluding, some reasons accounting for the advantage of the private lighting plant in many of the cases instanced will not be out of place. It has been claimed—and the contention is still maintained—that, on account of concentration of machinery, etc., in one large plant, under a trained engineer, the power required for lights, elevators, etc., should be produced and delivered more cheaply than in a number of small stations controlled by less competent men.

The question of the interest on the enormous cost of feeders and mains has been threshed over and over, as well as the other financial points involved, and it would be useless to renew the discussion. What requires emphasizing is the fact shown in the tables, compiled as they are from three times the number of plants cited, that the isolated lighting plant, *per se*, is not what we have to deal with in modern buildings. It is not required that a plant be installed with boilers, stack, engines, dynamos, etc., necessitating additional outlay for engine and boiler-room and an extensive staff engaged merely for the purpose of having the buildings properly lighted. The staff, with

the possible exception of some cheap labor, and everything but the engine and dynamo are essential, without the lighting plant, in all buildings requiring elevators and steam heat.

Again, the tables show little difference in the coal cost, whether a lighting plant is installed or not. This is readily understood when it is remembered that the lighting required in summer varies from one-sixth (in apartments) to one-half (in hotels) of that required in winter, and that during the winter the steam used for heating, if not obtained from the exhaust of the engines, must be generated directly. That "repairs are so expensive" is another point often brought up. In all the lighting plants, installed under competent advice, that have come under my notice there has not been one in which the repairs required amounted to more than fifty dollars a year in actual cash expended. The ordinary simple engine direct connected to generator need never get seriously out of order, if proper attention is given to it, and the necessary repairs can be made by the engineer.

Correct design of a plant is a most important factor in its economy. Generally a dynamo capacity equal to the maximum load is sufficient, as the small day load allows of inspecting and repairing one of the two or more units into which the installation should be divided. The units should not be of the same size, but each of sufficient capacity to enable it to operate the lights, etc., during a portion of the day with an economical steam-consumption. If electric elevators are employed, some slow starting device or storage batteries must be used, in order to obtain both light and power from the same generating apparatus without causing annoying flickering in the lamps.

The deduction to be drawn from the figures cited are self-evident, and may be summed up as follows. The central-station service can successfully compete with the private supply in small installations, whether separate or aggregate, and in large installations where the load is large and of short duration. In all other cases the power can be delivered more cheaply by the private plant on the premises, though local influences may make its installation inadvisable.

FIFTY YEARS OF ADVANCE IN MARINE ENGINEERING.

By Ridgely Hunt.

THE number of merchant steamers of 100 gross tons and upwards, in the world, exceeds 13,600: their total gross tonnage is more than 17,800,000. By gross tonnage is meant register tonnage,—borne on the books of the custom houses; it expresses in tons of 100 cubic feet the volume of the spaces actually available in a ship for remunerative service, such as the conveyance of passengers or the stowage of cargo.

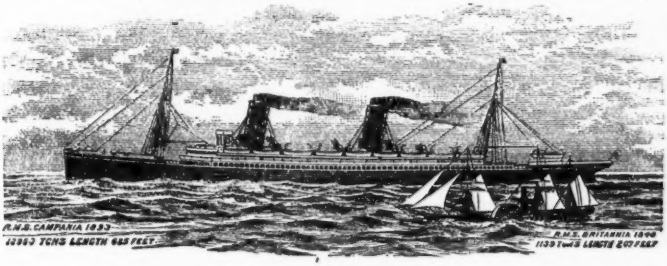
The 13,600 steam vessels may be classified, according to the material of which their hulls are constructed, into about 1,200 wooden, 6,400 iron, and 6,000 steel steamers. It is interesting to know that this vast fleet is but a generation old, the result of a development begun and expanded to its present proportions entirely within the last sixty years. Even the material of which the modern steamship is built is a production of to-day, for, though steel was introduced in 1873 as a ship-building material, it was not generally accepted as such until 1880. Ten years before this, iron was adopted instead of wood, notwithstanding the fact that for fifty years—the first iron steamship having been laid down in 1838—iron had been strongly advocated. Wood, of course, has been in use from time immemorial.

The cardinal advantages which iron possesses over wood as a material of which to build ships are lightness and strength. In ordinary merchant steamers the saving in weight of a hull of iron over one of wood is about 30 per cent. Mr. W. H. White, in his "Manual of Naval Architecture," explains the matter as follows:

> As an illustration, take a tie-bar of oak one square foot in sectional area; it would have an ultimate tensile strength of about 570 tons, but would only be trusted with a moving load of 55 to 60 tons. An iron bar of equal weight would have a sectional area of one-ninth square foot and a tensile strength of 320 tons, but, owing to its superior elasticity and the confidence felt in its uniformity of strength, it would be trusted with a load of from 65 to 80 tons. Or, to state the comparison somewhat differently, an iron bar capable of safely sustaining the same load as the oak bar need only have an ultimate tensile strength of 260 tons, which would be equivalent to a sectional area of 13 square inches. The oak bar would weigh 54 pounds per foot of length; the equivalent bar of iron would weigh about 45 pounds per foot of length.

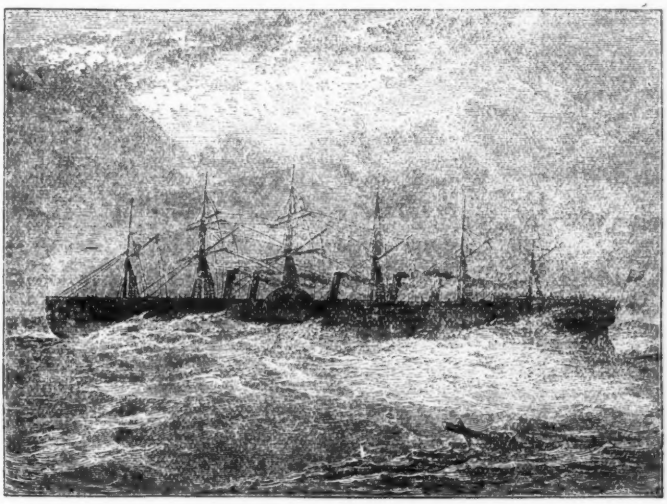
Steel is a superior metal to iron because of its greater strength and elasticity, by virtue of which it can be trusted to stand heavier strains. In building ships of steel there is a saving of weight over iron of about 15 per cent.

The other advantages of steel over iron and, in turn, of iron over wood, in the way of durability, method of construction, and safety, are apparent from what has been said. What is more important to notice here is the influence that the adoption of metal for ship-



THE FIRST AND LAST CUNARDERS.

building has had in tending to develop the modern steamship as exemplified in those vessels of gigantic proportions to day steaming into

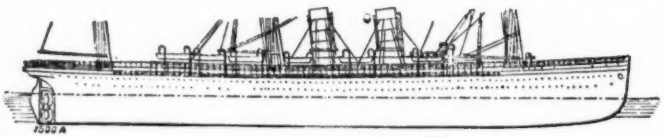


THE GREAT EASTERN AT SEA.

and out of our ports with the speed of locomotive trains. It is impossible to imagine that such vessels could be achieved in wood.

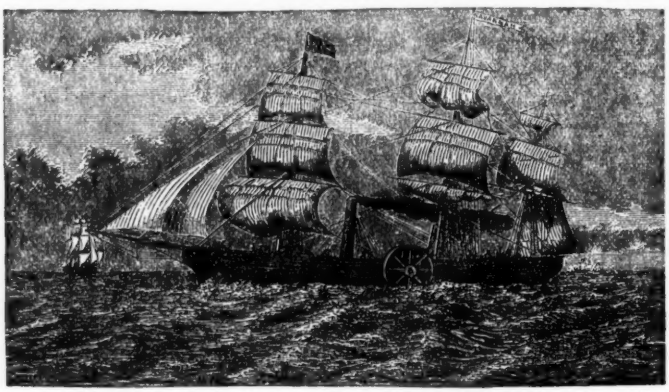
In the last half-century also engines have advanced from simple to

compound, and then to triple-expansion; so, too, have paddle-wheels been discarded for single propellers and for twin propellers; so, too, have single rectangular boilers with one flue, been replaced by several



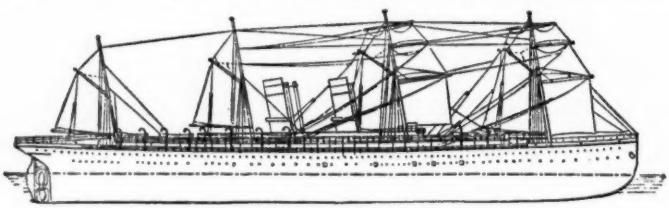
UMBRIA AND ETRURIA, 1884.

boilers, cylindrical, and with many tubes; so, too, have jet condensers been transformed into surface condensers, and the steam pressures



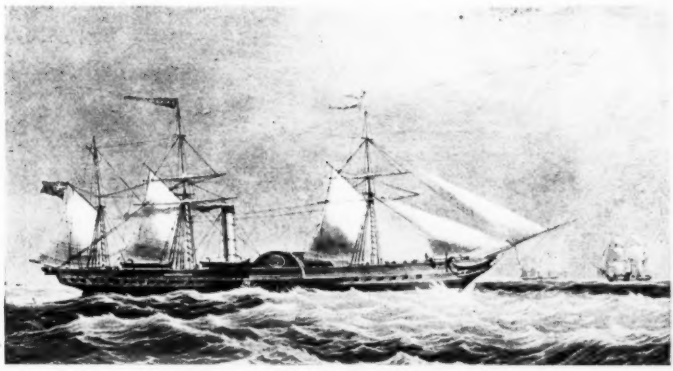
THE SAVANNAH OFF CAPE CLEAR, JUNE 17, 1819.

been raised from 10 to 100 and 200 pounds to the square inch; the size of steamships has been multiplied twentyfold and the horse



ALASKA AND OREGON, 1881.

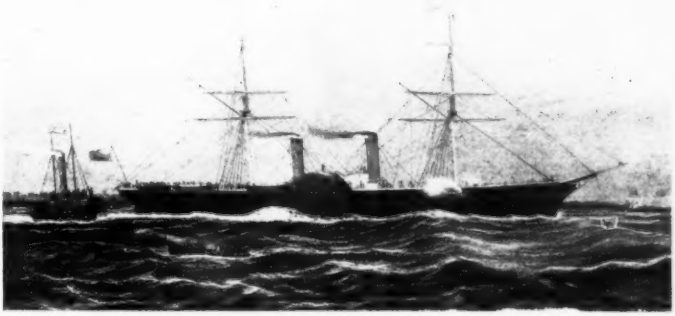
power fortyfold. The speeds of the ships have been increased from 8 to 17 and 23 knots; and in every other respect has there been



CUNARD ROYAL MAIL PADDLE STEAMSHIP BRITANNIA.
207 ft. x 54 ft. 4 in. x 22 ft. 6 in. 1154 tons, 740 I. H. P. Built on the Clyde 1840. Cargo capacity, 225 tons, and she carried 115 cabin passengers.

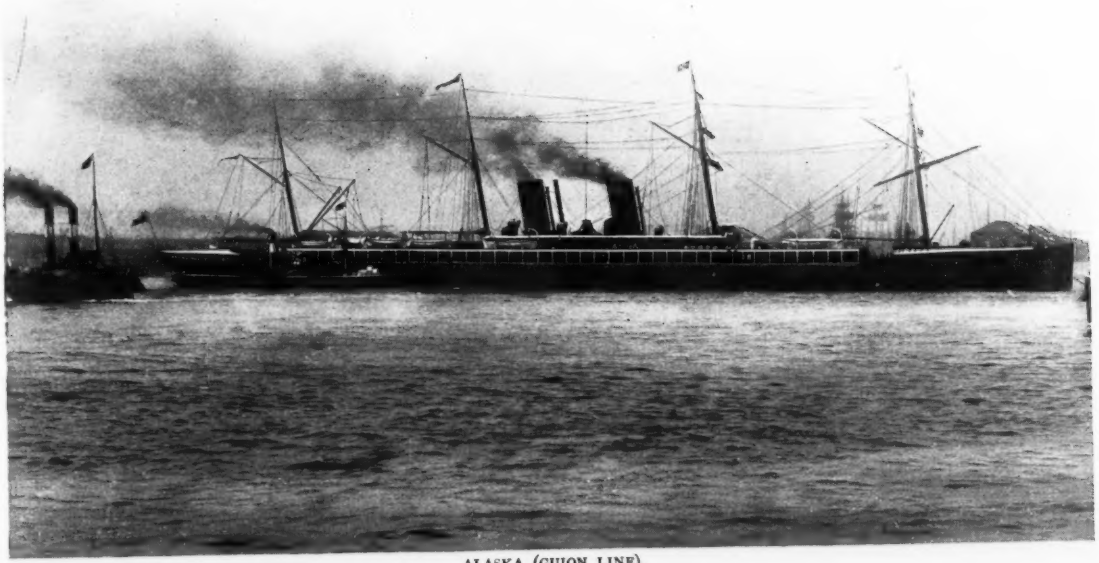
a like extraordinary evolution. It is the purpose of this paper to indicate briefly how some of these conversions were effected.

The first commercially-successful steamboat in the world was Fulton's Clermont, in 1807. The first steamship to go into deep water was the Savannah, in 1819. The next, in 1825, was the English steamship Enterprise, from London to Calcutta. Next, in 1829, a ship steamed from England to the West Indies, and then, in 1833, the Royal William (built in Canada), steamed to England. The wisdom of employing such vessels for ocean traffic was much questioned, many

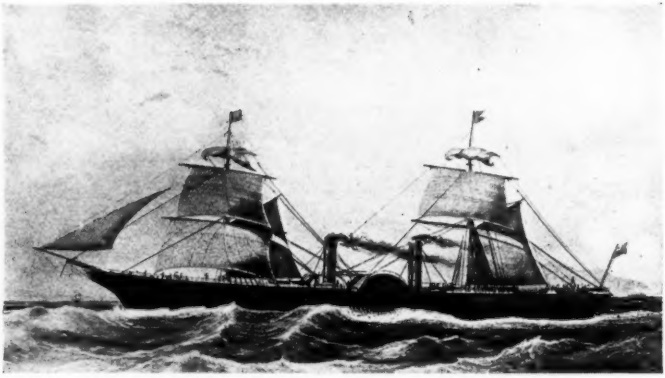


CUNARD ROYAL MAIL PADDLE STEAMSHIP ARABIA. BUILT 1852.

STEAMSHIP PERUVIAN.



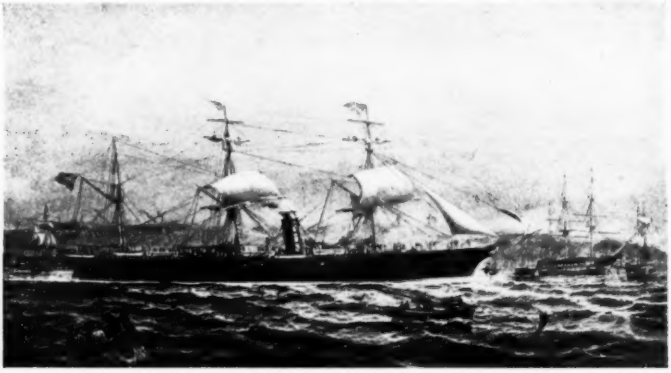
ALASKA (GUION LINE).



CUNARD ROYAL MAIL PADDLE STEAMSHIP PERSIA.
3,300 tons. 3,600 I. H. P., with accommodations for 250 cabin passengers. Built 1856.

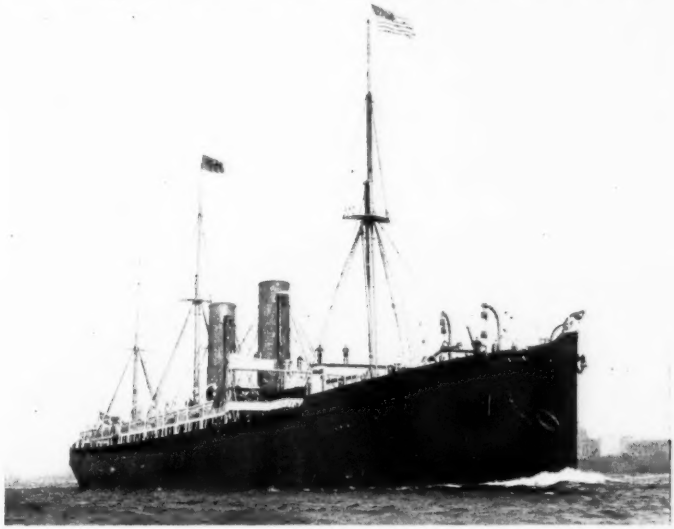
men urging that, because steamers could not carry coal sufficient for long distances, and because the expense of maintenance made any remuneration impossible, therefore long voyages should be made only by sailing ships. In these discussions the transatlantic route three thousand miles long was particularly considered. Not until the year 1838, when the Sirius, of 700 tons, and the Great Western, of 1,340 tons, steamed into New York harbor from England, was the practicability of navigating the ocean by steam alone triumphantly established.

It is not intended to give many details of particular ships. Some,



CUNARD ROYAL MAIL STEAMSHIP RUSSIA.
35 ft x 43 ft. x 27 $\frac{5}{12}$ ft. 2,960 tons 2,800 I. H. P. Speed 13 knots. Built in 1867 on the Clyde. Lost on the coast of New Jersey.

however, are needed to illustrate with distinctness the progress made in the evolution of the steamship. Thus the advent of the Great Western was an event of importance in deep-sea steaming, because she was the first vessel constructed especially for a long sea-voyage. In size she greatly exceeded anything built up to her time, being 236 feet long, 35 feet broad, and 17 feet draft. Her engines were of the side-lever type, with two 74-inch cylinders and a piston stroke of seven feet, which drove her paddle-wheels at the rate of twelve revolutions a minute. There were four iron rectangular flue boilers, supplying steam of eight pounds' pressure to the square inch; the coal

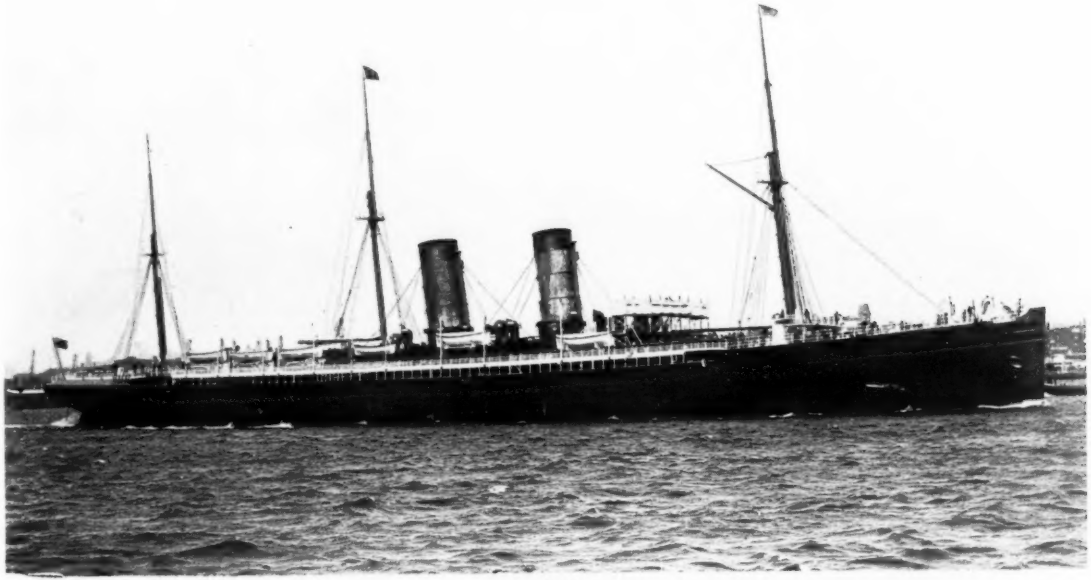


SERVIA.

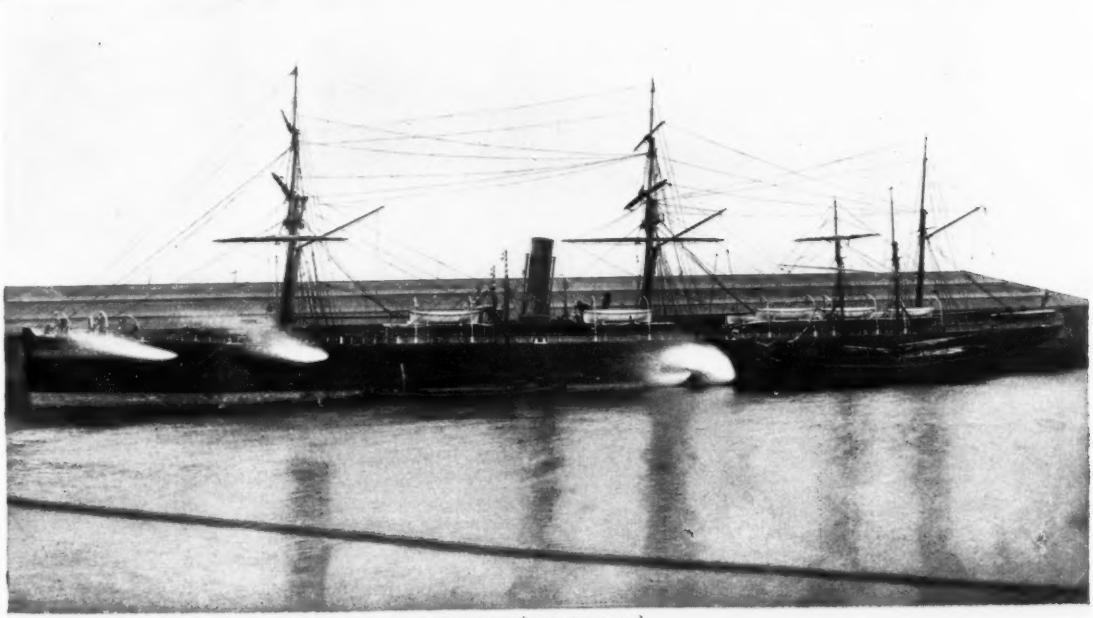
consumption was about 75 tons a day; the h. p. was 750, and the speed was 8.2 knots.

The permanent setting in of the tide of progress in the building and designing of ocean steamships began with 1840. From that beginning, only fifty-seven years ago—easily within the memory of many a man now among us—there has been an advancing, sometimes rapid, sometimes sluggish, towards the present mark. Now the tide is at a stand, but it will doubtless be flowing again in a short time.

In 1840 was organized the famous Cunard steamship company for the purpose of conducting trade and carrying the mails at regular intervals between Great Britain and the United States. Four wooden



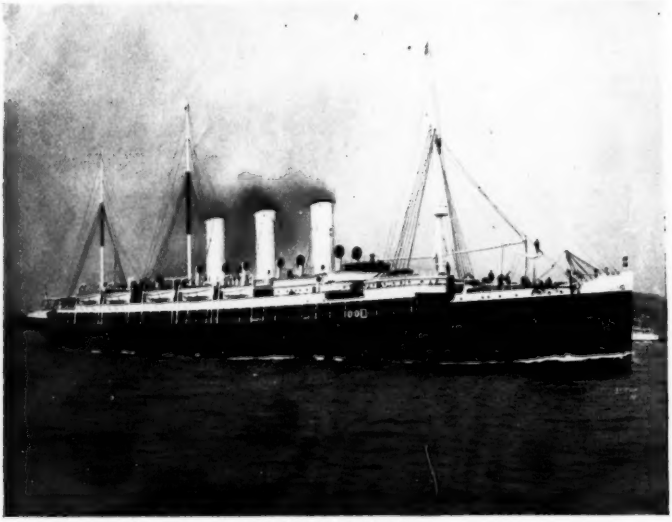
UMBRIA.



BOTHNIA (CUNARD LINE).

paddle-wheel steamships, the very best that man's ingenuity could devise, were put into service. The dimensions of the Britannia, the first one, were: length, 207 feet; beam, 35 feet; draft, 17 feet; tonnage, 1,154 register. She had side-lever engines, with two 73-inch cylinders and a stroke of seven feet; there were four rectangular boilers and twelve furnaces; the steam pressure was 9 pounds per square inch; the i. h. p. was 740, the speed 8.5 knots, and the coal consumption 38 tons a day.

The success attending this venture of the Cunard company stimulated other organizations. Presently a line of steamers was started for



AUGUSTA VICTORIA.

Mediterranean ports, and soon afterwards lines were in operation reaching to every quarter of the globe. The steamship itself was thus brought into prominence, and its improvement enlisted the efforts of many men of scientific attainments. Already the unsuitableness of the paddle-wheel had been discerned, the chief practical difficulty being connected with the constant changes in the immersion of the floats. In long voyages the consumption of coal and stores lessened the draft of the vessel considerably; hence, wheels effective at the beginning of the passage, would be much less so at the end. Further, the rolling of the ship at sea affected the action of the wheels; at one moment a wheel would be completely submerged, and

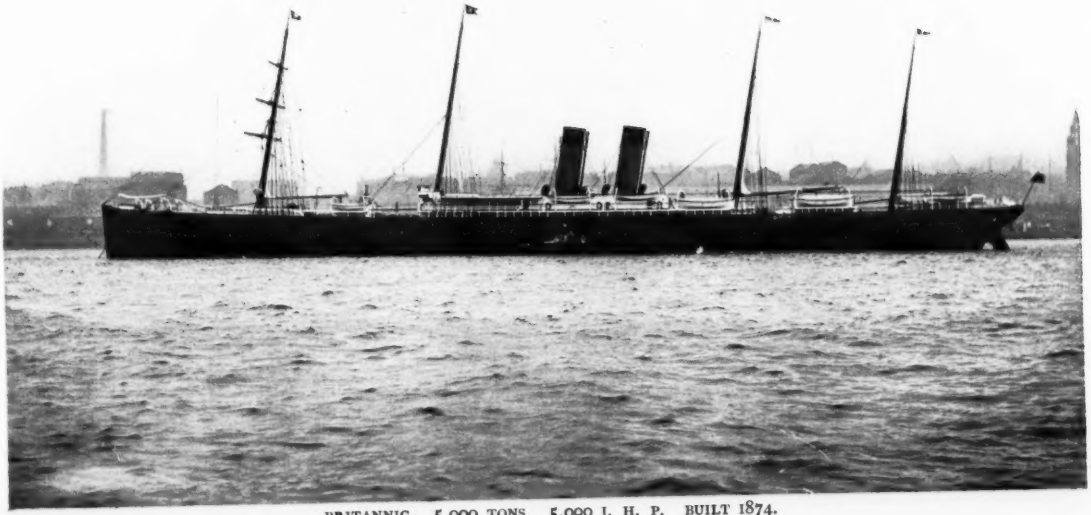
the next be altogether out of the water, causing the engines to race violently and endangering the machinery. To obviate these difficulties the screw propeller was introduced.

Some time before this, the screw propeller had been invented and tried. In 1836 Ericsson put it to the test, and in 1838 he fitted it to a small iron boat 70 feet long. Here a new material of construction and a new method of propulsion were introduced together; a still further innovation, in the Stockton, was a direct-acting engine, with 16 inch cylinders and 18-inch stroke. This ship, which sailed across the Atlantic to the United States, was the first propeller in our waters. Ericsson followed her.

The crowning effort of this epoch, and at the same time a most daring leap into the future, was the launching in 1843 of the steamship Great Britain, designed by Brunel, the genius who afterwards designed the Great Eastern. The Great Britain justly ranks as the most astonishing achievement of the day in marine engineering. Up to the time of the Great Britain's exploitation and for a great many years afterwards, steamships were built of wood, and were propelled by paddle-wheels; but the Great Britain was built of iron and was propelled by a screw. Although she was not the first ship in the world to be so constructed and so engined, yet she was the first of her kind designed for deep-water cruising. Properly speaking, the Great Britain was the prototype of the modern steamship of steel with twin screws. Her dimensions were: length, 322 feet; beam, 51 feet; draft, 17 feet; tonnage, 3.400, register. Her engines were of the geared pattern, with chains wound on drums, instead of toothed wheels; one turn of the engine gave three turns to the screw. There were four cylinders, 88 inches in diameter and with a stroke of six feet; the screw was six-bladed, 15.5 feet in diameter and 25 feet in pitch; the coal consumption was 70 tons a day; the speed was a fraction over eight knots.

The nautical world condemned the principles involved in the construction and machinery of the Great Britain; her engines, her material, her large coal-consumption, her limited bunker capacity, her speed, the expense of her maintenance and the costliness of her designs, deterred further experiments on the same lines. Instead, marine engineers devoted their talents to perfecting wooden steamships and paddle-wheels. Screw propulsion, however, attracted the serious attention of several naval authorities; in 1843 the French government fitted a frigate with an Ericsson screw, driven by direct-acting, horizontal engines, placed below the water-line of the vessel—the first machinery of the kind ever put afloat. In 1845 the English navy tried for the first time a propeller with blades of varying pitch.

OCEANIC. 3,707 TONS. 3,500 I. H. P. BUILT 1870.

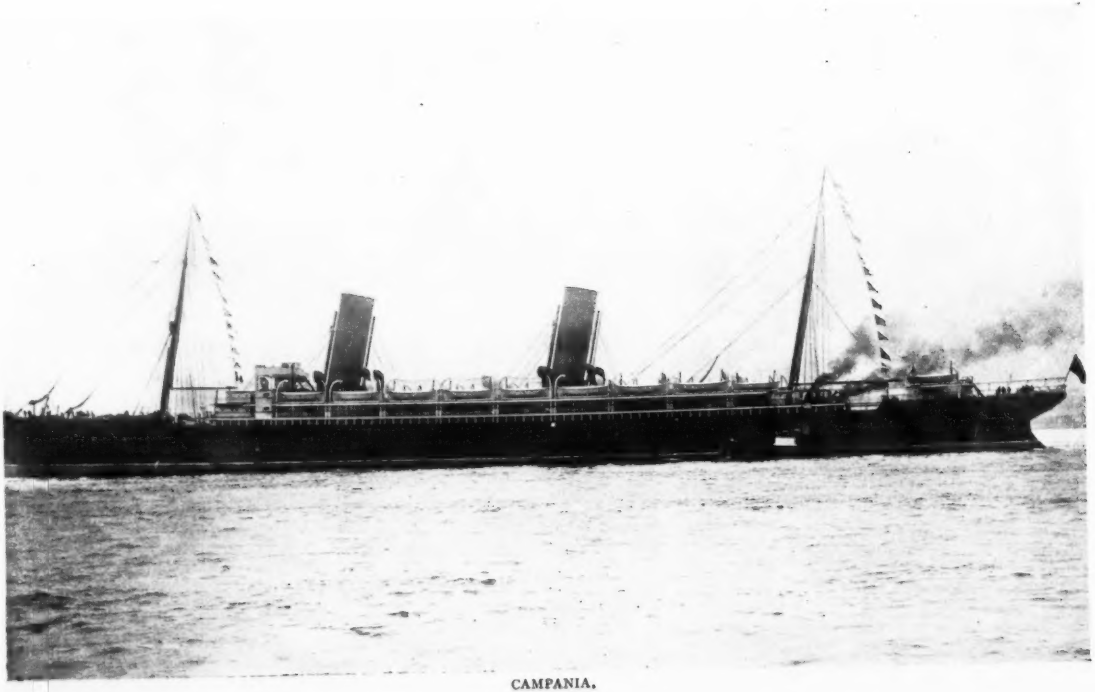


BRITANNIC. 5,000 TONS. 5,000 I. H. P. BUILT 1874.

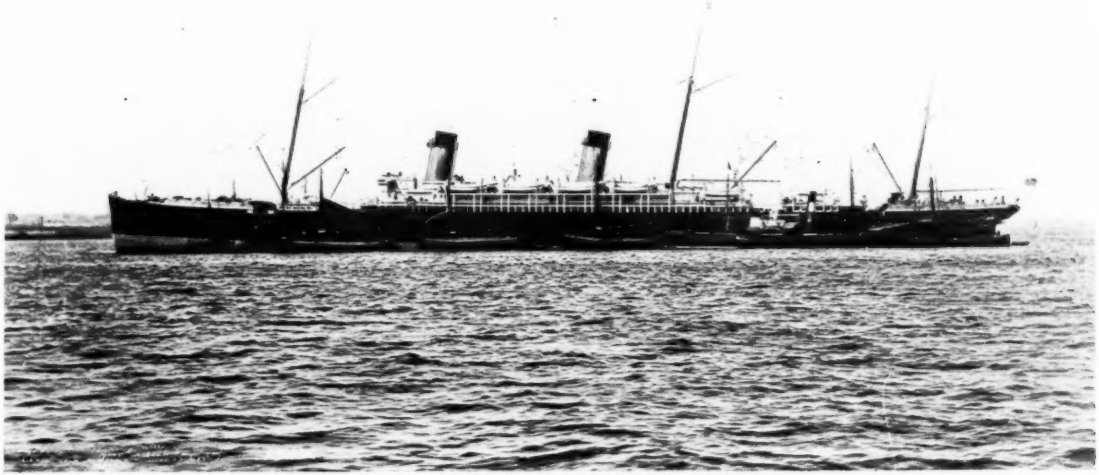
Perhaps more progress was made in screw propulsion and in improving the models of ships, by the United States than by any other country. At that time the government launched the man of war Princeton, of 1,000 tons. The machinery was designed by Ericsson, and his genius was discernible in many other strange features of this novel craft. The engines had double or compound semi-cylinders of different diameters, with double pistons placed in opposite directions, both being acted upon by the steam at the same time, their differential force being the effective motive power of the engine. The diameters of the semi-cylinders were 20 inches and 72 inches; the stroke was 96 inches, and the nominal h. p. 250. There were three iron rectangular boilers with semi-circular tops. Another innovation in the Princeton was a telescopic smoke-stack. The propeller had a cast-brass hub, with six blades 14.5 feet in diameter, and 32 feet in pitch. The performance of this extraordinary machinery, when operated under a steam pressure of 12 pounds per square inch and burning 1,300 pounds of coal an hour, was a speed of 6.3 knots. In 1847 the Princeton was fitted with return drop circular flue boilers; the same pressure resulted and the same speed. The revolutions of the screw were 25 a minute.

The model of the Princeton was peculiar. She had a very flat floor amidships, with great sharpness forward and excessive leanness aft. The run was remarkably fine. Lindsay, in his "History of Merchant Shipping," states that, in thus departing from the style of round or bluff bows and full sterns previously prevailing, and substituting a fine entrance and a clean run, American naval architects were the first to improve the form of steam vessels. By these important alterations and by subsequently making the length of merchant steamers at least eight times the beam, ship-designers succeeded, even during the infancy of marine steam propulsion, in raising the speed from nine to thirteen knots, and in giving to the world lines for the modeling of ships vastly superior to any hitherto adopted.

The steam history of the decade following is quite as wonderful. At the very commencement many new ocean-going steamers were put afloat, in which were embodied in substantial form nearly every conspicuous feature hitherto essayed experimentally. The improvements in model, in motive power, and in habitability which particularize this era can be attributed primarily to the influence of the intense rivalry among different steamship companies in their efforts to gain the control of the rapidly-increasing and remunerative Atlantic trade. Ships built of wood were matched against ships built of iron; paddle-wheels were in the running against screw propellers; and long, narrow, deep hulls were pitted against short, chunky, broad ones.



CAMPANIA.



MAJESTIC (WHITE STAR LINE).

To three well-known steamship companies should be given the credit for thus materially furthering the cause of steam navigation: first, to the Inman company, for boldly and with rare foresight placing in commission a fleet of large sea-going, iron steamers, propelled by a screw: second, to the American Collins line, for superiority of model, internal arrangements, and fine machinery; and, third, to the Cunard line, for excellence of construction and general efficiency. The point of radical difference between the American and Cunard ships lay in the boilers of the former, which were arranged with double furnaces and lower water spaces connected by a row of vertical tubes around which the heated gases circulated.

As ship followed ship in those days, so did improvement follow improvement, each vessel, no matter by whom put afloat, possessing certain characteristics which made her a better sea-boat than her predecessor. How great this onward movement was, and how thereby the steamship was benefited, can be best understood by stating some facts pertaining to two famous ships,—the Britannia, of 1,150 tons, built in 1840 of wood, and the Persia, of 3,870 tons, built in 1856, of iron. The former consumed in a voyage 570 tons, the latter 1,400 tons, but the cargo capacity of the Persia was 750 tons to the Britannia's 224 tons. The Persia was the largest steamer in capacity of hull and steam power that had ever been built. For two and a half times the quantity of coal, she carried nearly three and a half times the quantity of cargo, "which can be attributed to increased engine efficiency as well as to increased size of hull." Both ships had jet condensers and simple side-lever engines, but the boilers of the Britannia were of the flue type developing 9 pounds of steam, while those of the Persia were of the tubular pattern developing 30 pounds. The speed of the former was 8.5 knots; of the latter, 13 knots. The refinement of the lines of the hull of the Persia should also be noticed, one of the primary conditions of high speed being fineness of form; the length of the Persia, more than eight times her beam, indicates that she was modelled with a fine entrance and a clean run; the Britannia was but 6.4 times as long as she was broad.

But the crowning effort of the time was the launching in 1856 of the Great Eastern, built for the East Indian trade. She was of gigantic size, unequalled even to-day by any ship afloat, and in other ways she was remarkable, many distinguishing traits of the modern steamship appearing first in her. She was divided interiorly into several water-tight compartments; from keel to water-line there was a second hull, three feet inside the outer one,—the double bottoms of to-day,—and the method of bracing and securing the huge structure was the cellular system. In the light of our present knowledge of

naval architecture, the Great Eastern exhibited in herself the most astonishing progress. Unfortunately the propelling machinery and coal capacity were inadequate and far behind the other features in development.

Most naval constructors at this time were perfecting what had thus far been experimentally successful. After 1860 iron gradually took the place of wood as a ship-building material: surface condensation was substituted for jet condensation; and the screw was adopted as better than the paddle-wheel. The engines in use while these improvements were maturing were only variations of those used twenty years before; the side-lever, the geared, the oscillating and the direct-acting were the types most common; they were all fitted with jet condensers, consumed from four to five pounds of coal per hour per h. p., and worked with pressures of about 25 pounds. The advantages following the adoption of surface condensation, permitting fresh water to be fed to the boilers and thus minimizing the loss of steam by blowing off, were a diminution of coal consumption to about three and a half pounds, and a raising of the steam pressure to about 40 pounds.

A still better move in economy and efficiency was the introduction of the compound principle, working steam at a high pressure in one cylinder and afterwards at a low pressure in another cylinder. There was nothing new in this principle, but its application to marine engines was novel. The Pacific Navigation Company of England was the first to try compound engines, fitting them in two vessels, the Valparaiso and Inca, in 1856; the cylinders were two high-pressure of 50 inches and two low-pressure of 90 inches. As the old boilers and jet condensers were left in the ships, the working pressures of steam were only 25 pounds; but, despite these drawbacks, the engines were considered satisfactory, though the maritime community at large refused to accept the type until better steam generators were made. From which it seems that the elaboration of the compound engine depended on improved boilers. These came along shortly, after 1860, followed by a corresponding betterment in marine engines. There was thus effected a saving of fuel, the consumption per hour per h. p. when the engines were compounded being about two and a half pounds: subsequently this was reduced to 2.11 pounds.

With increased steam power there also came increased size of hull, care being taken not to repeat the mistake made by Brunel in the Great Eastern, of providing inadequate machinery. In the tonnage launched in the seventies greater size of hull is as conspicuous a feature as greater power of engine: another point to observe is the refinement of the lines of these large hulls. The advent of the White Star line in 1870 was the opening event of importance of this era, that

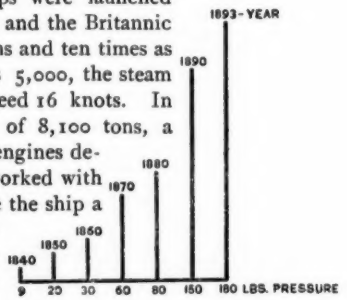
company placing in service a model class of ship. The Oceanic, the initial vessel of the fleet, had the lines and symmetry of a yacht, and such superior internal arrangements, that they have been substantially adhered to in all steamships since laid down. This Oceanic, of 3,700 tons and 420 feet long, has, after a quarter of a century of work well done, been retired to make way for a new Oceanic 704 feet long,—25 feet longer than the Great Eastern; in depth and size the new leviathan and the old will be about the same. It was predicted, when Brunel's great ship proved so signal a failure, that never again would such a monster be attempted, and that thereafter large steamers would more nearly approach 500 feet than 700 feet. Just forty years have passed since the advent of the Great Eastern, and present developments warrant this new prediction,—that all ocean steamers, whether for freight or for passengers, will hereafter more nearly approach 700 feet than 500 feet.

To return to the seventies. It is remarkable to note the extraordinary progress achieved even in the short time since the Britannic made her first voyage in 1840. Though measuring 1,140 tons, she had a capacity for only 225 tons of cargo, whereas the Bothnia, of 4,335 tons, built in 1874,—for her day a model screw ship, with all the improvements then known to ship-designers,—carried about 3,000 tons of cargo, nearly 14 times as much, though herself only about four times larger. The Britannic steamed 8.25 knots, the Bothnia 13 knots; and the latter steamship did all this extra work on less than half the quantity of coal per h. p. per hour, and on about the same quantity for the actual number of miles run. In other words, the engines of 507 nominal h. p. in 1874 drove a vessel of 4,335 tons at a speed nearly twice as great as that at which engines of 425 nominal h. p. drove a vessel of only 1,140 tons in 1840, and with not half the consumption of coal.

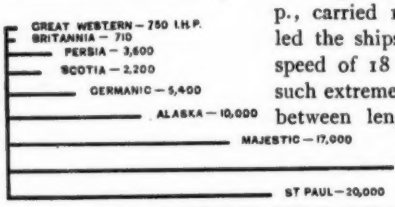
Compound engines were generally fitted after 1870, with surface condensers, tubular boilers and propellers. In the making and designing of this machinery there were many improvements whereby the rate of consumption of coal was reduced and the weight of the engines and boilers was lessened; pressures, as a consequence, increased, and so, too, the speed of the pistons. Soon the receiver type of compound engine was put in service; and, when the steel boiler with corrugated flue was introduced, it became very efficient. With the best iron boilers the pressures could be maintained at 60 pounds, without unduly sacrificing weight of boiler to safety, but with the steel boiler the great strength of the metal permitted not only the use of less thickness, but also the safe carrying of steam at much higher pressures. Ninety pounds was raised with confidence, with the result

that there was a decrease in the consumption of fuel from 2.11 pounds in 1871 to 1.9 in 1881; there was a like acceleration of piston speed,—from 366 feet a second to 466 feet a second.

Several world-renowned ships were launched during this epoch; the Germanic and the Britannic were two of them, of 5,000 tons and ten times as long as broad; the i. h. p. was 5,000, the steam pressure 60 pounds, and the speed 16 knots. In 1881 came the City of Rome, of 8,100 tons, a leviathan for those times; her engines developed nearly 12,000 i. h. p., worked with ninety pounds of steam, and gave the ship a speed of 18 knots. At this time also appeared the Alaska, of 7,000 tons, the first so-called "greyhound" of the pack that have since been coursing across the Atlantic. She was 500 feet long and fifty broad, of 10,000 h. p., carried 100 pounds of steam, and led the ships of the world with her seaspeed of 18 knots. The advisability of such extreme proportions as ten to one between length and breadth was after this somewhat modified, quite as good results following. Shorter ships are handier, have greater stability, and stow more cargo.



INCREASE OF STEAM PRESSURE IN 50 YEARS.

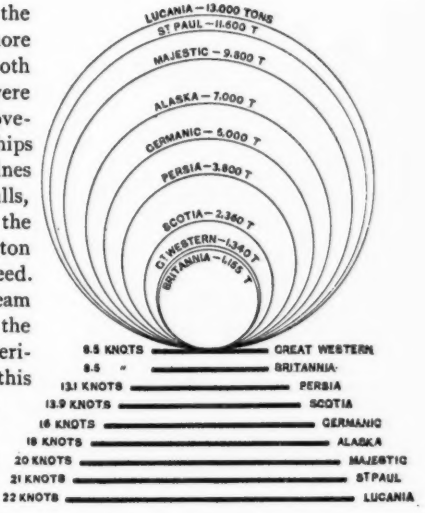


INCREASE OF HORSE POWER IN 50 YEARS.

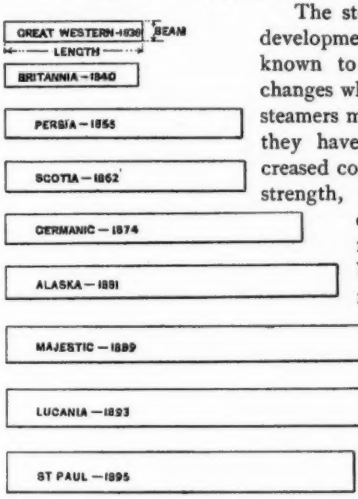
From the compound engine to the triple-expansion engine was a natural step. It had been attempted in 1874 in the English steamer Propontis, but had proved abortive because of inadequate boiler pressure. The steel boiler and attendant improvements in steam-generating made triple-expansion a success; one hundred and fifty pounds of steam were demanded, and this demand was easily met. Statistics collected from a number of ocean steamers show that the average consumption of coal when the engines were simply compounded was, as above stated, 2.11 pounds, with boiler pressures of 45 to 60 pounds; in the receiver type the consumption was reduced to 1.9 pounds, and the steam pressures rose to 90 pounds; in the triple-expansion type the pressure rose to 150 pounds, and the amount of coal consumed was reduced 18 per cent.

Mild steel as a ship-building material was first employed in 1880 in the Buenos Ayrean of the Allan line. It was not tried before this,

because of its expense; the more it cheapened, the more it was used. Presently both ship and machinery were constructed of it. Improvements followed, in both ships and machinery. Better lines were observed in the hulls, more powerful grew the engines, faster the piston strokes, and higher the speed. Soon 180 pounds of steam were carried. Finally the Inman line, now the American, decided to utilize this vast power by working it off in two screws instead of one. Ten years ago, therefore, the Paris, the pioneer twin-screw merchant steamship of the world, made her appearance.



COMPARATIVE TONNAGE AND SPEEDS.



INCREASE OF LENGTH AND BEAM OF STEAMSHIPS IN 50 YEARS.

The story of what has followed in the development of the steamship is too well known to need repeating. To-day the changes which have occurred in merchant steamers may be summarized as follows: they have acquired increased speed, increased coal endurance, greater structural strength, much better water-tight subdivision, improved pumping facilities, greater beam, double bottoms, steam-steering gear, forced draft and twin screws. Some of the changes were brought about largely as the natural development of the merchant trade. In part they have been due to special effort. All have improved the commercial value of the ships themselves.

MINE ACCOUNTS.

By J. Parke Channing.

A SYSTEM of accounts at the mine should show accurately the various items of expenditure entering into the cost of the unit of production, be that the ounce of silver or gold, the pound of copper, lead, or zinc, or the ton of iron ore or coal.

To the investor or the capitalist the total cost is the main point of interest; to the manager of the work the itemized divisions of this total cost should be of paramount importance. From them he is enabled to see the varying effects of different methods of operation, of new apparatus, and of different classes of labor. He is enabled to compare the cost during each month with that during preceding months, or with corresponding costs in other mines under similar conditions. Accounts should be so differentiated that the effect of every condition entering into the cost of production may be calculated in dollars and cents. Money may be expended for labor and for supplies. It is necessary, therefore, that the labor classification and the record of supplies used should be amplified to the utmost.

Time may be kept by foremen, or by timekeepers, or by both. It is generally preferable to have the foremen do this work; besides being more accurate, it compels them to keep closer run of their men. In case the number of men under one foreman are numerous, he may have the timekeeper as his assistant. In addition to turning in at the office each employee's name with the number of shifts worked and the rate per shift, there should be a daily report of the men employed, giving the number at each rate of wages at each particular class of work. At the end of the month the summation of these daily reports should equal the summation of the pay-roll sheets, always in days and usually in money, unless there be contract labor whose rate per day cannot be determined till the end of the month. Avoid the return of "Laborers" at the end of the sheet; a laborer must be doing something, and it is better to state exactly what he is doing, and allow the manager or the chief clerk to determine where his time shall be charged.

Where the property is large and there are foundries, machine, carpenter, boiler, and blacksmith shops, the time of the men should be charged by the hour and at the actual rate against the particular piece of work on which they are engaged. Pro-rating these shop charges of time leads to very inaccurate results.

The three steps in recording time are: first, the time sheets;

second, the labor-classification book, in which the time is distributed against the various accounts; third, the pay-roll, where the time of each man is drawn together, and his debits and credits recorded.

In charging supplies, the best practice seems to be to charge everything as it comes in to a supply account, or one of several different supply accounts, and, as the material is used, to credit supply account and charge to the correct operating expense. The advantage derived from this procedure is that it makes the treatment of material uniform, and the checking of requisitions, invoices, and bills of lading and the charging out follow the same lines, be the article a keg of nails, which may be eventually charged to one of a dozen different expenses, or a new hoisting engine, which can go only to equipment.

Freight on supplies, together with the local cost of handling and distribution, is charged against the supply accounts, and fixes the price at which articles shall be charged against the expense accounts. Fictitious profits on supplies or profits from shops should be avoided, as they simply tend to incorrect divisions of the total cost. There is nothing in this restriction to prohibit the charging of powder to contract miners at a high price, but, when this powder is charged in the cost sheet, it must be at the cost price plus the cost of handling and wastage.

All expenses may be divided under the three heads of construction, maintenance, and operating expense, and, as has been indicated, labor and supplies are the two classes of items entering into each. The question of a capital account in mining operations is one of extreme delicacy. From the very nature of its operation, a mine grows intrinsically less valuable each day, on account of the removal of some of its ore. Its marketable price may increase, however, if development is going on more rapidly than exploitation; yet, as ore does not grow in old stopes, the property is really of less value from day to day. Differing, therefore, from a farm, a railroad, or a cotton mill, a mine has a certain period of existence after which, with all its equipment, it becomes practically valueless. With but few exceptions it is impossible at the beginning to foretell the length of this period. In the case of some coal mines and of the horizontal iron-ore deposits of the Mesabi range in Minnesota, preliminary drilling may give a very close approximation of the total number of tons of mineral available, and this, divided by the proposed yearly product, will give the life of the mine. The uncertainty of the duration of this period suggests that the capital account be sunk as soon as possible, so that the books may be placed on a conservative footing.

There is no doubt that construction expense should be kept separate from maintenance and operating expenses. Its final entry as an item in the cost of production may be either by a yearly percentage charge from construction account, or by a direct entry each month, construction being considered as one of the operating expenses. The latter way is the safer, and is adopted by one of the largest copper mines in this country.

There is a tendency among subordinates, which is not always absent even from the manager, to make construction the dumping-place for many items that should go to maintenance or operating. This should be closely guarded against; nothing should be charged against construction which, in the nature of things, is really a repair or a renewal.

It perhaps is an error that in most mine accounts there is no distinct division between maintenance and operating expenses. As a rule, the maintenance of a hoisting engine or of a stamp mill goes in with the operating expenses, the whole being turned in as hoisting or stamping. There is no valid objection to this, if these expense accounts are sufficiently amplified to show all details.

While the total number of expense accounts which may with propriety be kept is indeterminate except with reference to a particular case, the following list will serve to indicate the principal final divisions of cost: (1) Exploration; (2) Construction; (3) Sinking; (4) Drifting; (5) Raising; (6) Stoping; (7) Timbering; (8) Tramming; (9) Hoisting; (10) Pumping; (11*a*) Stocking; (11*b*) Rock-House Treatment; (12) Loading; (13) General Surface Expense; (14) Railroad Transportation; (15) Stamping or Milling; (16) Office; (17) Superintendence; (18) Insurance and Taxes. There will be many more accounts, which will be charged or closed out monthly into the representative expense accounts.

Exploration will be charged with the preliminary work on the property, such as pits, trenches, drill holes, prospect tunnels, or shafts. As soon as the mine is shown to be of value, these charges should cease, unless outlying work of a similar nature or underground drilling is to be carried on.

When the mine proper is started, construction will be the first account of importance. As its name indicates, it will cover the cost of all buildings, roads, foundations, and machinery. It is here that care should be taken to prevent lumping. There should be a separate account for every building, every foundation, every piece of grading, and every machine, or class of machine. Do not put up a 100-stamp mill and charge everything, from castings to bricks, into a mill

machinery account. The time will surely come when you will want to know the cost of some particular class of work.

To sinking should be charged all the costs connected with putting down the shafts and getting them in shape to receive the cages or skips. It will include the labor and supplies used in blasting the ground, hoisting the dirt, timbering the shaft, and putting in the guides or rails, ladders, etc. The cost of cutting and timbering the stations at the various levels should be kept separately, but the amount may finally be charged in to sinking or drifting, as one sees fit. The unit of work for this division will be the foot of shaft sunk and completed for use. In addition to this, however, the cost of sinking per pound or ton of product should be calculated.

In making up the account of drifting, which is the operation of driving the levels from the shaft, it is not usual to include the cost of handling the broken material. As a rule, that goes into the cost of tramming; sometimes, however, when drifts are let on a contract and the miners tram their own dirt to the shaft, it is difficult to separate the two items.

Raising as well as Winze Sinking are figured out on the basis of the number of feet raised or sunk, as well as the ratio of their cost to the product.

Stoping includes the cost of drilling and blasting down the ore, so that it is in position to be loaded in cars and carried out. To arrive at the true cost of stoping, the number of tons actually stoped should be used as a divisor,—not the number of tons hoisted. It may be that a large part of the ore, coming from the drifts, should not be credited to the stoping.

In some mines it is customary to make a division of sinking, drifting, raising, winzes, and stoping into the two general classes of Opening and Breaking. Opening then includes the cost of shafts and drifts up to the point where ore is encountered. As soon as the drifts get into ore and are making a product, their cost goes in with stoping under the general head of Breaking. The following example will indicate the results of an incorrect divisor. Let us assume that our mine is in such condition that we have no sinking or rock work to do in a certain month, and that we produce 22,000 tons of ore, of which 2,000 tons come from 500 feet of drifts, and the balance from regular stoping. In the ordinary way the cost-sheet summary might appear in part as shown below.

In reality, however, the $1,000 paid for drifting produced 2,000 tons of ore, which cost $ .50 per ton, and the $5,000 paid for stoping produced only 20,000 tons at a cost of $ .25 a ton, and not $ .227, as the cost sheet would lead us to infer. The actual average

cost of breaking the 22,000 tons of ore under the condition of the month is $ .272. The necessity of having these figures correct when one is to make estimates of future cost under given conditions is evident.

COST OF MINING 22,000 TONS ORE, SEPTEMBER, 1897.

Account.	Expense.	Cost per Ton.
Sinking		
Drifting	$1000.00	$ .045
Stoping	5000.00	.227

Timbering includes the cost of the timber, its preparation, and its putting in place. Shaft timbering should be charged to sinking. Tramming is the cost of loading the broken ore or rocks into cars, and transporting it to the shafts. The cost per ton should be based on the total number of tons handled, be it rock or waste. Allowance should be made for timber handled. Hoisting is to be calculated on the number of tons of material actually hoisted. Pumping should be figured on the basis of million gallons ; also the ratio of its cost to the finished product. In case the ore has to be put on stock pile, the expense of top men is charged to Stocking Ore. In case it runs through crushers and screens, these men would be charged, along with crusher men, to Rock-House Expense. Where the ore is run immediately into railroad cars, this expense comes under the head of Loading. Where ore has to be stocked, and then loaded at a later time in the year, Loading may be an important account. In most mines loading ends the handling of the ore, but, in cases where the company owns its own rail or tram road to the mill, Railway Transportation comes in. If ore is carried one way and fuel and supplies the other, an up-freight on the fuel and supplies equal to cost should be charged to them and credited to transportation, so that the balance of expense may represent the cost of handling the ore. Stamping or Milling should be based upon the material actually run through the mill. General Surface Expense, as its name indicates, covers necessary expenses on the surface of a mine, such as cleaning up, taking care of buildings, etc. Office involves expense of clerks, stationery, telegrams, etc. Superintendence may appear as an account by itself, or it may be charged into the various representative accounts. It seems preferable to have it include only general officers of the mine, and to charge foremen's time directly to their department. A better-looking cost sheet is made if Insurance and Taxes are charged each month,—one twelfth of the total,—than if they are put in as a lump sum once a year.

Each boiler house should have a separate account, to which should be charged firemen, water, fuel, and repairs. This is charged, in proportion to the steam used, to hoisting, pumping, compressing, etc. If an engine does both hoisting and compressing, then there should be a separate account for it, so that its expense may be properly divided. The cost of producing compressed air should be kept to itself, and charged to air drills, hoisting, and pumping, as the case may be. An air-drill account should be kept, and the total cost of air-drill repairs and sharpening charged to sinking, drifting, stoping, etc., on the basis of drill days.

At the end of the month a cost sheet should be made out from the data furnished in the regular books. This may be either a single large sheet, or a book of numerous small pages. While the large sheet does very well for a general *résumé*, it is undeniable that, when the work is of any magnitude, the book is much more satisfactory. Here each page can be devoted to some particular division of the work, and all the details and results given. Fig. 1 is a copy of one of the sheets used at a certain Lake Superior iron mine; while it may be open to criticism in minor details, it is, on the whole, very good.

In case there is a regular reduction of tonnage because of discarding waste material, the method of ratios produces good results. Suppose at a mine 10,000 tons of vein is mined to produce 3,000 tons of ore, and that this 3,000 tons, if concentrated by water, will produce 1,000 tons of concentrates, and that this 1,000 tons, if smelted, will produce 100 tons of matte, which is shipped. Assume that it costs $3 to mine, $1 to concentrate, and $4 to smelt, and that, although only 9,500 tons of vein were mined for the month, 1,100 tons of concentrates were smelted, the stock being drawn upon. What did the matte cost per ton? We have the following ratios: ore to vein material, 30 per cent.; concentrates to ore, 33⅓ per cent.; matte to concentrates, 10 per cent.

COST OF PRODUCING MATTE, SEPTEMBER, 1897.

	Amount.	Per ton of Matte.
Mining 11,000 T's vein.....at $3..	$33000.00	$300.00
Concentrating 3,300 T's ore.....at $1..	3300.00	30.00
Smelting 1,100 T's concentrates.....at $4..	4400.00	40.00
Coat of producing 110 tons Matte.....	$40700.00	
Cost of producing 1 ton Matte.....		$370.00

Had the actual total mining cost for the month been used, 9,500 tons at $3.00 per ton, $28,500, it would have shown a fictitious lower

.....IRON MINING COMPANY.

Statement showing Cost of Producing.....Tons of Ore during.....18....and for Producing.....Tons from.....189..to.....189..

EXPENSE ACCOUNTS.	For ..... Month.			For Previous M'ths			For .....Months		
	Expenses.		Cost per ton	Expenses.		Cost per ton	Expenses.		Cost per ton
	Labor	Supplies		Labor	Supplies		Labor	Supplies	
MINING EXPENSE.									
201 Opening									
202 Stoping									
203 Timbering									
204 Tramming									
205 Cage and Skip Tenders									
206 Pumping									
207 Compressor and Air Drills									
208 Underground Tracks									
209 Mining Captains									
210 Shift Bosses & Timekeepers									
211 Gen'l Underground Exp'se									
212 Hoisting Expense									
213 Diamond Drilling									
214 Picking and Sorting Rock									
SURFACE EXPENSE.									
301 Stocking and Sorting Ore									
302 Shipping Ore									
303 Warehouse									
304 Office									
305 Surveying and Chemistry									
306 Electric Light									
307 Air Fund Contribution									
308 General Repairs									
309 General Surface Expense									
310 Miscellaneous									
GENERAL EXPENSE.									
Taxes									
Insurance									
TOTAL COST for Month & Year									
COST PER TON " " "									
Add to reduce Equipment Acc't									
Total Cost per Ton									

PRODUCTION STATEMENT.

SHAFTS	Tons of Ore Mined.			
	For Month	Prev Months	For	Months
Production Mining				
Tally				
Add Overrun				
Total Production				
Shipments				
Balance in Stock, 189				

SUMMARY OF SUPPLIES USED.

CLASSIFICATION OF SUPPLIES.	Cost of Supplies		Tons Ore Mined.		Cost per Ton.	
	Month	Year	Month	Year	Month	Year
101 Explosives						
102 Candles						
103 Oils						
104 Drill Steel						
105 Iron and Steel						
106 Lumber						
107 Mining Timber						
108 Tools						
109 Steam Packing						
110 Gas Pipe&Fittings						
111 Carbons						
112 Fuel						
113 Miscellaneous						
Totals						

AVERAGE OF ALL LABOR.

	Rate Per Day.
Contract Miners	
" Trammers	
" Timber Cutters	
Average Company Account	
General Average of all Labor	

matte cost, and certainly a higher one the succeeding month, should stocks have been increased during that period. In cases where the reduction is small, as from 100,000 tons mined to 95,000 tons hoisted to 90,000 milled, the mistake is often made of adding the individual costs per ton to get the total cost, without introducing the proper ratios as multipliers.

There is another class of record which should be kept in every mine, as well as in every industrial establishment,—a record of Work Per Man Per Day. This record tells far better than a cost sheet whether the men are doing good work, as the effect of varying wages is eliminated. How many feet a day does a man sink in a shaft, how many tons does he break in a stope, how many ton-miles does he tram in a day,—these are questions of vital importance. A convenient form for this sheet is as follows:

SUMMARY OF LABOR SHEETS.

	Tons.	Feet.	Days.	Amount.	Wage.	Per man per day		Labor cost per	
						Tons.	Feet.	Ton.	Foot.
Sinking.....									
Drifting.....									
Raising.....									
Winzes.....									
Stoping.....									
Tramming..									
Landing....									

One very interesting figure is the number of tons of ore mined per day, divided by the total number of shifts worked during that day, from the manager down to the drill boys.

Each mine is different from every other mine, and, as no two mines can be wrought on the same system, so no system of bookkeeping will do for all mines. Each manager must adopt a system for himself; the main idea of the present article is to suggest the use of a logical method by which the various steps of handling or treatment may be followed up and analyzed as they occur in actual practice.

THE ECONOMICAL PRODUCTION OF POWER IN SMALL UNITS.

By E. T. Adams.

THE past decade has not been without its notable triumphs in the field of steam engineering. It has been a period of advance along familiar paths rather than one of epoch-making changes; indeed, broadly speaking, all progress, in the United States at least, has been along lines clearly indicated by the pioneers of twenty or thirty years ago; but along these lines the advance is notable. The goal of all progress is economy, and in no direction has the advance made during the past decade been more marked. Builders of standard types of boilers daily guarantee an evaporation which a few years ago would have been considered exceptional or unattainable, and the certainty with which, under favorable conditions, this evaporation will be brought to within a few per cent. of the results which represent the maximum efficiency yet attained is a remarkable evidence of the advance in this branch of steam engineering. In durability, closeness of regulation, and smoothness of operation, all types of the steam engine have been brought to a marvelous degree of perfection, and with large engines of certain types, under favorable conditions, the steam-consumption per i. h. p. has become exceedingly small. Little by little the combined efficiency of the best types of engines and boilers has been increased, until at the present time, under favorable conditions, the consumption of fuel per i. h. p. has been reduced to a point beyond which comparatively little reduction can be hoped for from present types of engine and boiler, or, indeed, from any system in which steam is the heat-bearing medium. Hence the attempts to reduce the number of transformations of energy, and consequent losses, which occur between coal-pile and line-shaft by the elimination of both boiler and engine,—that is, the conversion of the potential energy of the coal, by a single trausformation, into electrical energy, as simply summoned and as ready for prodigous effort as the fabled genii of Aladdin. This is the modern dream of energy direct from coal.

This maximum efficiency, however, which has summoned dreams of a new and brighter era in the production of power, and which to some has seemed to indicate that we have now practically reached the limit of progress in the development of the steam engine, has, up to a recent period, been attained only in the larger plants, with engines of five hundred to one thousand horse power and upward, working under especially favorable conditions. Now the conditions commonly met

in practice are wholly different. The engines are usually comparatively small, and the conditions far from favorable to their economical operation. Probably not less than ninety per cent. of the steam power in use in stationary land service in this country is developed in small stations, in engines of less than two hundred horse power each, working under conditions far from favorable to economy. It is safe to say that the efficiency of a small steam plant working under usual conditions seldom reaches fifty per cent. of this maximum efficiency which has so fired the popular imagination, and in at least one very important class of cases this efficiency is probably not higher than twenty-five to thirty-five per cent. of that secured in large plants under favorable conditions. It would seem, then, that the epoch-making change next to come is not the production of energy direct from coal, but, rather, changes making greater economy possible under the conditions commonly met in practice,—that is, more economical production of power in small stations.

There are many indications that changes which will make this possible are now in progress, and, while the next century may or may not produce light without heat, or power from coal without the steam engine, it is reasonably certain that the closing years of this century will see an increase in efficiency of plants of this class which, while it may not bring them up to the present standard of maximum efficiency, will be wider-reaching than any changes since the days of Corliss. In order to see how this is possible, it is necessary to consider the distribution of the cost of power, and also to investigate the conditions which have controlled the development of engines of moderate size.

The distribution of the total cost of power is, for small stations, approximately as follows: fuel, 40 to 50 per cent.; attendance, 25 to 30 per cent.; interest, about 15 per cent.; supplies and repairs, about 15 per cent. In a large station the distribution of cost is much the same, except that the cost of attendance is a smaller, and the interest charge a larger, percentage of the total. It appears, then, that the reduction of the cost of power which has been effected in the large stations has been secured by making some saving in each item (interest only excepted), which enters into the cost of power; and, reasoning by analogy, it seems probable that, if any reduction of cost is possible in the small stations, it must be made in the same way—by saving a percentage of each item which goes to make up the total cost. Further, if the cost of power at the small station is to be cut in half,—as it must be if there is to be any epoch-making change in the present practice,—it is probable that each item entering into the total cost must also be cut in approximately that proportion.

Is any appreciable reduction in the cost of power possible when that power is developed in a small station under the conditions commonly met in practice? In discussing this question the boiler and its adjuncts will not be considered; a saving, often of considerable magnitude, is nearly always possible, but the question, so far as the boiler is concerned, is simply one of proper selection and management, while the engine is passing through a stage of development which seems certain to produce either a new type, or a modification of some existing type, which, by reason of better fitness for the conditions, will be a most important factor in determining the cost of power in small stations. Fuel is the largest item in the cost of power. The fuel-cost depends chiefly on two things; first, on the efficiency of the boiler and engine chosen; second, on the possibility of operating both continuously at the load at which this efficiency is greatest. If, as usually happens, this load is variable, the engine can be kept at or near its miximum efficiency by employing several small units which may be brought into action or shut down as the exigencies of the service demand. It is largely due to such expedients as this that the cost of power in the larger stations has been so greatly reduced; but, when the power developed is already small, any subdivision of power implies the use of a very small unit of power,—that is, the use of a very small engine. Now, that a small engine is an uneconomical engine is so commonly true that it is usually accepted as necessarily true; we shall see presently why this is an error, but for the present it is enough to note that the first step toward higher economy is the development of small engines which shall afford a much higher fuel-economy than is usually secured at the present time.

The second large item is attendance. This will always be a large item in any small power station, but even with the high-speed engines, which have won their way for this class of service in spite of their manifest defects, the cost of attendance can be very greatly reduced by skilful designing. When properly designed, a small engine should not require more in the way of attendance than the services of some one to stop or start it, with occasional, say weekly or monthly, skilled inspection. If it requires more than this, cost of attendance has not been sufficiently considered in design. For example, bearings of ample proportions for the load they are to carry may become wholly insufficient. Taking into account the cost of attendance and the allowable frequency of adjustment; and complication not at all objectionable in a large engine, where the cost of attendance becomes a minor item, is not to be thought of for the small engines we are now considering. There is no excuse for the use of a multiplicity of small sight-feed oil cups, or for the dozen or more unneces-

sary joints or parts in the valve gear. These things require constant skilled attention; and more thorough lubrication, better regulation, and better steam distribution can be secured by other and simpler means. The bearings of a small engine should not be a copy, in miniature, of the bearings of the engine of larger power. It is largely on account of such designing as this that an engine of one hundred horse power often demands more skilled attention than one developing ten times that power. The bearings of the small engine should be few and abnormally large; the smaller the engine, the less should be the adjustment required; in fact, the necessity for adjustment should, by proper designing, be made to vary, say, inversely as the square of the power developed. At the limit—that is, for engines of five or ten horse power—adjustment three or four times a year should be ample. What a boon such an engine would be, what a necessity such an engine is, to the busy farmer, for example! The small engine demands automatic and copious lubrication. This is best secured by using some oiling system such as that adopted by Westinghouse, Willans, or the Ideal engine companies, or by the system lately adopted, at the writer's suggestion, by the Payne Engine Company. Each of these systems has its individual "points," but all are cheap, require absolutely no attention, are very economical of oil, and furnish oil continuously and in abundance to every bearing in the engine. The saving in engine friction due to this system averages five per cent. of the rated horse power of the engine, while the cost of oil and supplies is generally reduced to about one-tenth of the usual amount. All these things tend toward greater simplicity, and this means less first cost, less interest, and less expense for repairs, as well as less cost of attendance. That is, increased simplicity effects a reduction in every item entering into the cost of power, except the fuel-cost.

Now, greater economy in the consumption of fuel, which, when we consider the engine only, means a better steam distribution, is usually secured by increased complexity of construction, but it is not necessarily secured in this way. A steam distribution closely approaching that of the Corliss type can be secured with the simplest possible type of valve and valve gear. Variable expansion may be secured, and the evils of early release and either excessive compression or excessive clearance can be wholly avoided; perhaps the details of the way in which this may be accomplished are somewhat beyond the scope of this paper, but I may say that the clearance is kept down by the methods so successfully employed by Professor Sweet, and that by this and other equally simple means the much-abused plain slide valve, with the simplest connection to a single eccentric,

can be made to give a steam distribution approaching closely to that secured at the expense of so much complication in the Corliss and other types of valve gear.

If it is accepted as true that simplicity should be the controlling element in the design of a small engine, the choice is at once limited to three broad classes of engines,—namely, throttling, automatic, and the variable expansion engines having positively-driven valve gear; in the United States that in most general use is the single valve automatic. Now, with this type of engine there is usually a loss greater even than that due to excessive clearance or defective steam distribution. This loss is due to leakage past the valve, and "leaky" rather than "single" valve automatic would often be the proper title to use in describing this engine. This excessive leakage, however, appears to be a comparatively recent development. It has resulted from the attempt to secure very close regulation when the governor, by reason of complicated construction or some other cause, was unable to give good regulation, unless the valve and valve gear were practically frictionless. It is difficult to prevent the common types of balanced valves from leaking, especially when high steam pressures are used, but it can be done, if the governor is not too sensitive. When any balanced valve fits its seat closely enough to prevent leakage, there is certain to be considerable friction, and, while the force required to overcome this friction and the inertia of the valve is not great, it is only within a recent period that governors have been designed which give regulation within one per cent., and at the same time are powerful enough to drive a valve fitted steam tight. Governors capable of accomplishing this are now used by a dozen or more prominent high-speed-engine builders. All, or practically all, of these are designed according to the Rites system of governing. The principal feature of this system is the balancing of the gravity action of a single weight by its inertia, which allows the use of a construction of great simplicity. There is usually only one piece and only one joint in this governor, and governors designed according to this system have given practically perfect regulation when driving a plain, unbalanced slide valve. This and the system—due to Professor Sweet—of reducing the clearance space, the use of steam-tight valves, and the simple, but effective, system of steam distribution adopted, may be mentioned as important features of the type of high-speed engine now in its formative state, which seems likely to bear much the same relation to the usual type of automatic engine that the Willans engine, coming so extensively into use in Europe, bears to its prototype, the throttling engine. In every respect, excepting possibly first cost, this Willans engine fulfils the requirements which we have es-

tablished; but in the United States the prejudice against the throttling engine is very hard to combat, and, although the Willans engine has been on the American market for several years, it has, doubtless on this account, failed to secure the success it undoubtedly deserves. In England this engine has achieved a remarkable success, to which we may refer later as illustrating the effect of business conditions on engine design, and on the lines along which development takes place.

First cost is also important as determining the expense for interest and depreciation, but under present conditions, considering the fact that the engineer is seldom consulted in the purchase of small engines, first cost becomes the all-important factor; and it is certain that a small engine, no matter how economical it may be in operation, will not have a chance to demonstrate its superiority, unless its first cost is less than that of the engine with which it must compete, and this again indicates that simplicity must be the controlling element in design.

In so far as the engine can affect the cost of power, it is certain that this cost will be greatly reduced, and it is probably entirely safe to predict that in the near future small stations equipped with small engines will, at constant load, generate power at a cost that would be considered an average figure in Corliss practice under the same conditions; when the load is variable, the advantage will surely lie with the small engine. The engine, however, while it is an important element in determining the cost of power, is not the only one. There is a more important element affecting every item which enters into either the first cost or the cost of operation, and, indeed, with an influence reaching far back of this, and producing a marked effect on engine design. This is the general practice regarding the employment of a consulting engineer. For reasons which it is profitless to discuss, the usual practice is to erect the small steam plant without the aid of engineering advice other than that furnished *gratis* by the interested builders of the machinery installed. As an immediate consequence, the capacity of the plant is, in the majority of cases, considerably greater than is required. If this power were subdivided into a number of small units, a part could be worked at the best load for maximum efficiency, and the only loss would be the interest on the part standing idle; but, with the engines usually installed, this is not possible, and in the majority of small plants the engine is underloaded practically all the time to an extent that renders any approach to economy out of the question.

Under competent engineering advice the selection of the proper type of engine for the service demanded is made a valuable aid in securing economy, but, in the absence of such advice, the type of engine

chosen simply indicates the buyer's prejudices or the salesman's ability, and it is an even chance whether or not it will prove the engine best suited for the particular conditions. This same remark applies with equal force not only to the boiler and its accessories, but also to every detail of the plant. And reaching beyond all this is the demoralizing effect on engine design when all engines are placed on one level by a buyer incapable of judging accurately the merits of each. This leads naturally and certainly toward the cheap and gaudy in design and finish, toward "high art" rather than "high economy," toward nickel plate and fancy trimmings rather than good engineering and substantial construction, and the highest efficiency will not be reached until the lessons of experience and the pressure hard times shall combine to bring about a more rational state of affairs.

Whether the owner of a small steam plant shall continue to be his own worst enemy, or whether he shall realize that there are some tasks which demand for their solution something more than purely business training, it is certain that some advance will be made, and that this advance will be due to the further improvement of the small engine. Even under present conditions we find able engineers maintaining that in large cities the small lighting station is destined to replace the large central station with its high ground rent and heavy transmission losses. And for street-railway service a small increase in efficiency will at once bring up the question whether two or more stations conveniently located along the line is not better than the one large station which must be located within a certain circumscribed area, regardless of convenience or cost.

These are isolated examples, without the field conceded to the small engine; and, given the engine, simple, compact, cheap, and economical, the prediction seems safe that its influence on steam-engineering practice will be wider-reaching than any change since the days of Corliss.

THE GOLD FIELDS OF KLONDIKE AND THE YUKON VALLEY.

By Harold B. Goodrich.

A YEAR ago it would have been difficult to find many to whom Alaska meant more than the northwest corner of the map of North America. A reminiscence of the events of thirty years ago might come with the mention of the word. "Alaska,—O yes, that worthless frozen country which we bought from Russia for two cents an acre." The Yukon then was only a name. But within the last two months has come an entire revolution in the attitude of our people toward the great northwestern territory. Who has not heard of the Chilkoot pass, St. Michael's, and, greatest watchword of all, Klondike with its treasures, the uncovering of which caused such an excitement in the middle of July? At that time we entered upon a gold madness which has not been equalled since the days of the Cariboo stampede in 1859. It is true that the latest discoveries are situated within British territory, but so near to our frontier that we are greatly affected, and even consider them our own. The public began to realize what some had known for a long time,—that there are great possibilities in that territory of which Uncle Sam has taken so little care. Immediately upon the announcement of the newly-discovered Eldorado, parties were fitted out all over the United States, east as well as west, and these parties attempted to enter the country by all the different routes, even when the approach of winter made such entrance dangerous, and, in the opinion of "old-timers," well-nigh impossible.

Some of these parties, unsuccessful in their efforts, turned back; others, having crossed the Chilkoot pass or ascended the Yukon, are well on their way to the diggings, whence news of their doings may transpire at long intervals during the next few months. In this mad rush are hundreds who have never had any experience in Alaska life; some are "tenderfeet," who think that gold is to be picked up everywhere, and will be much surprised to find that they are obliged to work even harder for a living than "on the outside." There will also be an influx of the blackleg element, those non-producers who live on the production of others, and are justly despised by the better class of Yukon miners.

Before this time the population was a little more than 1,700, but with this sudden increase the character of the interior must utterly

change, and it is probable that even now the civilization which the writer had occasion to observe last summer has become historic. Here these people have lived and worked,—a cosmopolitan community made up of representatives of almost all races and walks in life. They are mostly Americans; they are practically beyond the jurisdiction of the courts, but they are not for that reason lawless. It was early appreciated that society must have some sort of protection. To this end the "miner's meeting" was established as the law-making body. This meeting consists of all the men who inhabit a certain district, or, as the population increased, all who work in a certain gulch. In this meeting every man has an equal vote. A chairman is chosen by the assembly, but his power is slight, and in all cases the majority rules. By this legislative assembly, which, by the way, has no regular time of meeting, but may be called at any time by public notice, all the laws governing morals and mining are passed.

It was by this assembly that Chinamen were excluded from the privilege of mining in the Yukon, and that murder was made a crime punishable by death. But the miner's meeting is not wholly legislative; it is the final court in all criminal or civil suits. Here the majority act as judge and jury, there are none but volunteer lawyers, the weightiest questions are decided, and the decision is generally carried into effect without delay.

At first these hardy pioneers rendered decisions of the most puritanical strictness, and there was little or no crime. In a measure this immunity has been due to the obstacles in the way of entering the country and the extreme difficulty of living when once there; for nowhere is seen a clearer illustration of the principle of the survival of the fittest. The dangers to be encountered upon the "trail" to the diggings, and the hardships to be endured, have weeded out all those unfitted to a pioneer life, and the result is an entire community of sturdy men, capable of almost unlimited physical endurance.

Of late years, however, as might have been foretold, the establishment of precedents has led the miners into several mistakes; at times, perhaps, there has been a personal bias which has made the decisions actually bad. At any rate, among the more conservative miners the "miner's meeting" is not now revered as formerly.

Last summer, in one of the British creeks in the Forty Mile district, there was a clash between the self-appointed government and the Canadian mounted police stationed at Fort Cudahy to preserve order. A claim owner had not paid the men employed by him, and the miner's meeting voted to sell his claim to satisfy this demand; but the soldiers were sent to the gulch, and this decision was rendered void. On the American side of the boundary line there have been no

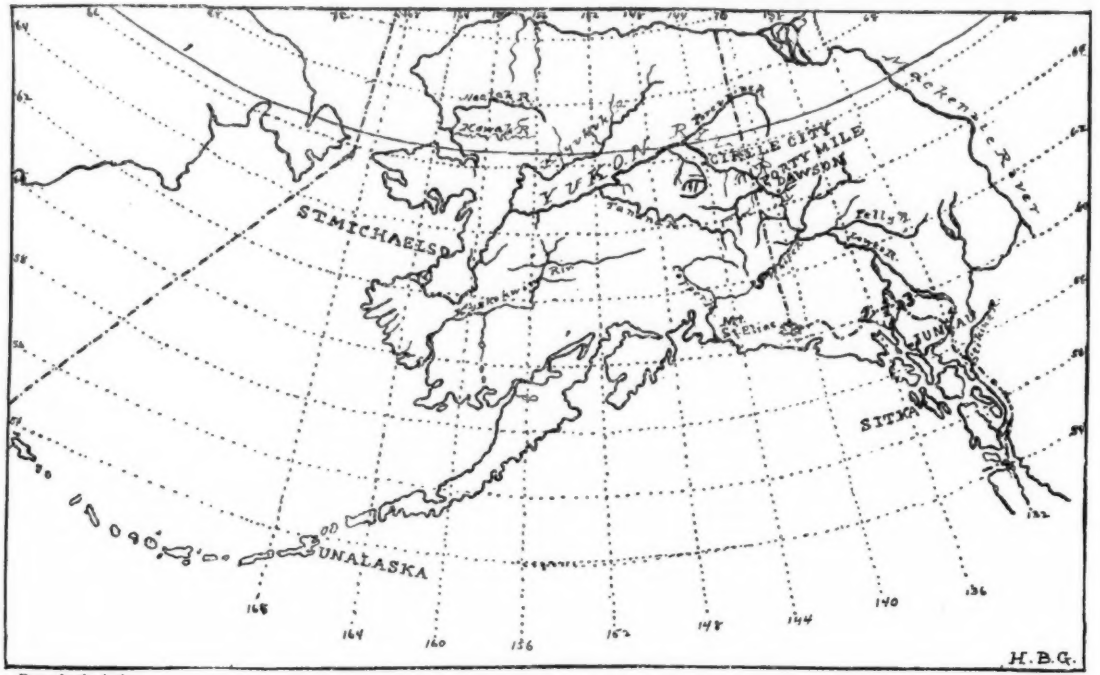
officers corresponding to the mounted police, the only representatives of the government being two custom-house officers sent to Circle City last summer, and the authority of the miner's meeting has never been questioned. Under its rulings, mining has been carried on, and all have lived harmoniously. If, as has infrequently happened, a man has been convicted of stealing,—the crime next to murder in heinousness,—he is whipped at the post and sent out of the country.

Placer mining is the only kind practised, and it is carried on in the most primitive manner. Bar and gulch diggings are the two types of occurrence. The former consist of gravel deposits in the quiet portions of running water, and are found in points of land, or islands in the stream. In earlier days these placers, which contain generally fine and far-carried gold, were the only ones worked. At present, however, although a certain amount of "bar-rocking," as it is called, is carried on along the main stream of Forty Mile creek and others, this form of digging is not nearly so important as that of the gulches.

In the bar the "rocker" or cradle of the Californian days is generally employed. More complicated machinery, however, is used in some localities. Flumes have been built which convey a head of water sometimes a half a mile, and the necessary force for sluicing is also obtained by raising the water from the main stream by a water-wheel. Two of these have been erected, one on Forty Mile and one on Birch creek. They are fifteen feet in diameter, float in mid-channel, and are supplied with cup-paddles. But even with these appliances very few bar-diggings produce more than ten dollars a day per man, which, under existing conditions, is the lowest yield that can be made profitable.

Gulch diggings are deposits of gold-bearing gravels which have been made in the valleys of the smaller creeks. The gold in them is generally coarse, bearing the character of nuggets, and has not been carried to any great distance from its place of origin. Geologically speaking, the gravels are recent, and have invariably been deposited in running water—not by glaciers, as is sometimes thought, for there has been no glaciation in the gold region. They occupy the lowest part of the trenches which have been excavated in the surface by the running water. The present stream often takes a slightly different course from that which it pursued at the time of deposit, the result being that the gravels are cut and exposed at one portion, while at another the water flows over bare bed-rock.

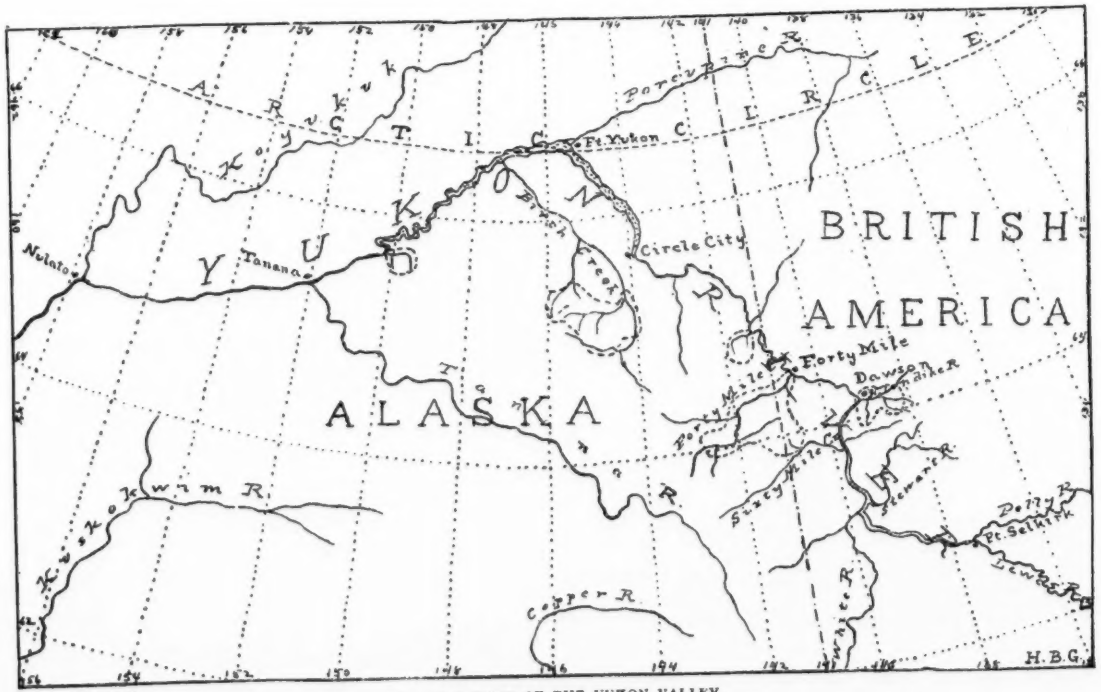
The thickness of the gravel varies from head to mouth of the same creek and between different creeks, and so there is a distinction between shallow diggings, in which the deposit is thin, and deep diggings, where it is from fifteen to twenty-five feet thick. The Klon



Drawn by the Author.

MAP OF ALASKA, AND PART OF BRITISH AMERICA.

1, Chilkat Pass; 2, Chilkoot Pass; 3, White Pass; 4, Taku Pass; 5, Scoloi, or Nicolai Pass.



Drawn by the Author.

MAP OF A PART OF THE YUKON VALLEY.

Showing the areas in which placer mining is being carried on. Scale, approximately 1 in. = 100 miles.

dike placers are of the latter kind, and often in its gulches there are twenty-five feet of gravel deposit between the soil, or "muck," and the underlying bedrock. These gravel deposits are usually not gold-bearing throughout their entire thickness, but are divided into the "barren gravel" and the "pay streak," the latter being generally at the bottom and varying greatly in width and thickness.

In the Klondike district, on Bonanza creek, four feet of pay dirt has been reported with a width of thirty feet, yielding from fifty cents to one dollar to the pan all through. The bed-rock underlying the gravel is often found to contain gold, and it frequently pays to mine this, particularly when it is decayed and loose for a foot or so down. On Eldorado creek in the Klondike district it is said that profitable bed-rock is three feet thick.

Having found the pay streak under the mass of barren gravel, the prospector pursues different methods to reach it. If there is no great thickness of gravel, the miner "ground-sluices" the claim with the water from the creek, and, having stripped the gravel, shovels it into sluice-boxes, where the heavy metal is separated from the lighter gravels and is caught by the strips called "riffles" on the bottom of the boxes. It is finally recovered in the "clean-up" by amalgamation with mercury. This is done in the summer-time, and the amount of production depends largely upon the accidents of climate, for the working time may be cut short by the continuance of the spring flood period, or toward the middle of August drought may come, and last until the country freezes up in the middle of September.

Thus it happens sometimes that a summer's working-season is only sixty days long, and it is obvious that claims must be very rich indeed to make up for that short season. To obviate this difficulty, the miners have endeavored to extend their operations to cover the whole year, the severe winter as well as the genial summer, and the method of "burning and drifting" has been evolved. For these "winter workings" shafts and tunnels are driven, as in ordinary bed-rock mining, through the frozen gravel, but, in place of powder or dynamite, fire is used. A large blaze is built upon the surface, and by it the ground is melted. The thawed ground is then removed, and a shaft is started. By continuing the process the shaft finally reaches the pay streak, which is mined and laid by in dumps until the water flows in the spring, when it can be washed.

It can be seen that this is particularly advantageous in deep diggings, and it is a fact that all the large "stakes" have been taken out by winter working. For instance, previous to the development of Klondike, the largest amount ever taken out on one claim was $45,000, won by John Müller, on Miller Creek of Forty Mile District,

"TRACKING" TO THE GULCHES.

Drawn by H. T. Pratt from a sketch made on the ground by the author.

mainly by "burning and drifting." Klondike itself has typical winter workings, and it was by this process that all the large amounts of gold brought to San Francisco in July were extracted.

Until the discovery of Klondike the development of the interior had progressed in Alaska proper, toward the west, and the output had increased until in 1896 the production, exclusive of that in British territory, was in the neighborhood of $1,000,000. All this (as later the $2,000,000 or more of gold from the Klondike) was taken out by summer and winter workings with a minimum outlay of capital. The miners have whipsawed their lumber themselves, and made their own simple sluices and cradles, which, with gold pan and shovel, have constituted their entire mining outfit. Hydraulic mining has not even been attempted, and, while there is much gold-bearing quartz through the different placer areas, the expense of all kinds of machinery has precluded actual "quartz mining." It has, in fact, been the bane of the country that, on account of its severe climate, it is not self-supporting, and that difficulty of communication with the "States" has made the cost of living extraordinarily high. Correspondingly wages are high,—$10 a day, or a dollar an hour, and, during the first of the Klondike excitement, even higher. This is the reason why all placers whose product falls below $10 a day for each laborer must be abandoned, as stated above.

An expert on gold and gold-mining, Mr. Joseph De Lamar, recently published the statement that Alaska can never be compared with California, because of the difficulty of living there. It is undoubtedly true that the severe climate has greatly delayed the development of Alaska. Few wished to invest capital in a country where, because of its isolation during the long winter, the risk is so great and the returns so slow. To a certain extent, however, these difficulties can be overcome, and, if the Klondike stampede is for a time disastrous because of its unexpectedness, in the end it will undoubtedly be highly beneficial. The tide of capital has set that way. Alaska will no longer be a "poor man's country," but, by the competition which will obtain between rival companies, it may reasonably be expected that the cost of living will be materially reduced, machinery be brought in, and mining in an improved form be put on a permanent basis.

In order to accomplish these results, ingress and egress must be made easier. Up to the present time there have been two principal routes by which the gold fields are reached. One is by steamboat from Seattle or San Francisco, across the North Pacific to Unalaska in the Aleutian Islands, and thence to St. Michael's, near the mouth of the Yukon. From here a transfer is made to the flat-bottomed river

GULCH MINING.

Drawn from a sketch made on the ground by the author.

steamboats which navigate as far as Dawson City, a distance of nearly 1,800 miles. Supplies have heretofore been brought into the country in this way by a journey of 4,000 miles, but the miners prefer the second route over the Chilkoot pass, by which they can reach the diggings about a month earlier. The Chilkoot pass route is full of difficulties, as is well known. Generally the miner crosses it in the early spring, before the lakes at the head of the Yukon are clear of ice, builds his small boat on Lake Linderman, and sails down the river, carrying his provisions with him.

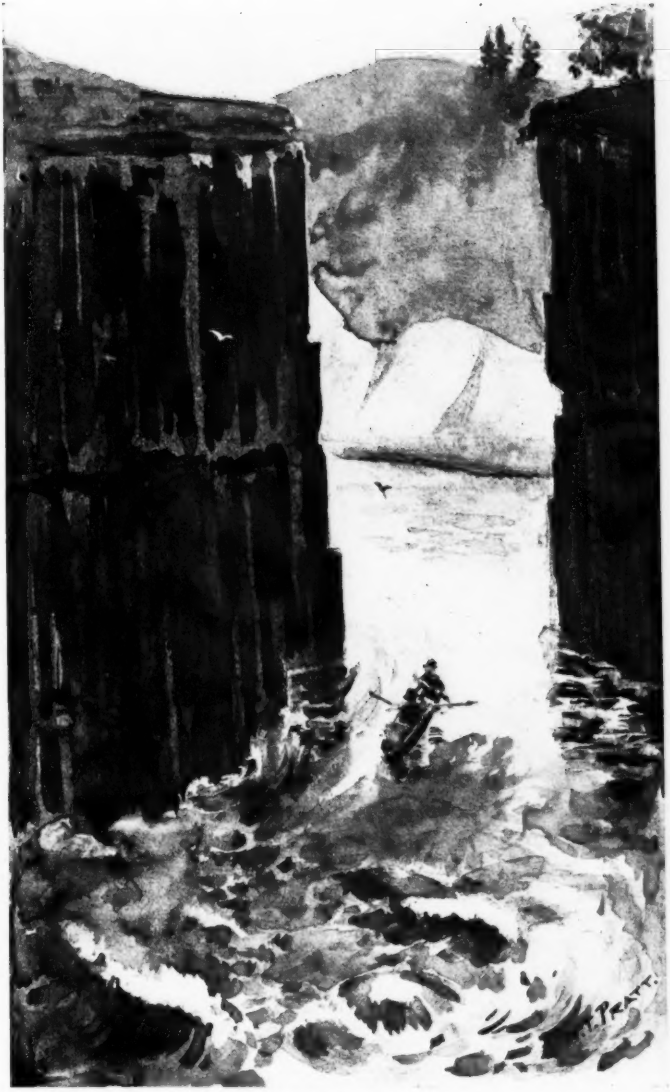
The point he most dreads is the Miles cañon, where the Lewes river narrows to fifty feet and plunges between basalt walls at a rate of twenty miles an hour. The cañon itself is only five-eighths of a mile in length, but there is a vast amount of experience crowded into the few seconds of its passage. As one miner expressed it after going through the cañon:

"I wouldn't have missed that trip for fifty dollars!" and then significantly added: "But I wouldn't make it again for five hundred."

The cañon spreads out in the middle, forming a circular eddy, and a story is told of two Swedes, whose boat, carried out of the main current, circled about in this central basin for many hours, while they were wholly unable to guide its course. At last, when they were worn out with terror and fatigue, a caprice of the current sent them dashing and plunging unexpectedly through the lower part of the cañon. The White Horse Rapids, three miles below this dangerous spot, is even worse, and in its turbulent plunge many valuable outfits and even lives have been lost. There are also other less dangerous rapids still further down, through which the miner passes on his way to the camp.

While the ocean voyage and passage up the river will, of course, be maintained on the lower Yukon for purposes of traffic and supply, some more direct route to the gold fields of the upper river must be established in the future. The journey by way of the Chilkoot pass—"over the trail" in the language of the miners—is the shortest one to the headwaters of the Lewes river, but, on the other hand, from the salt water at Dyea across the Coast range to Cañon lake, the way is one of the greatest difficulty. The summit of the pass is 3,560 feet above sea-level, and is reached only by the hardest climbing. It is obvious to all who are acquainted with this region that a railroad through it would involve an immense expense.

There is, however, another pass, which crosses the coast range a little further to the southeast. This is known as White pass (No. 3 on map), so named by Mr. Wm. Ogilvie, the experienced Canadian surveyor, in honor of a Minister of the Interior of the Dominion. Its



SHOOTING MILES CAÑON.

Drawn from a sketch made on the ground by the author.

altitude is 2,600 feet above the sea. From the mouth of the Skagway river in Taiya inlet to its summit the distance is seventeen miles, nine of which are said to be through a cañon which presents great obstacles; but the approach to the lakes on the north of the Coast range is easy, and the route is reported to be practicable. It is lately reported that the Canadians have built a trail through it, and are laying a telegraph line into the interior.

Supposing the headwaters of the Lewes to have been reached by a railroad through either the Chilkoot or the White pass, the river affords an easy line of travel for four months of the year. During this time, while it is free from ice, flat-bottomed steamboats of light draft can be used. The main difficulties to be overcome are shallow water and rapids. Light-draft steamers on the Lewes could pass all these, with the possible exception of the White Horse, which, however, with the Cañon, could be avoided by a steamboat route through Lake Ahklen down the Hootalinqua river. An entrance to this line would be made through the Taku pass (No. 4), about 75 miles from Juneau. Its feasibility as an approach to the interior was demonstrated by Schwatka and Hayes, who in 1891 made the trip through it to the Yukon valley. The objection to this route is its length.

As I have stated, the river would be open to travel only from the middle or last of May to the middle of September. It might be advisable, then, to have a railroad down the Yukon. Could one be put through cheaply from salt water to the diggings? Chilkoot pass is unsuitable; so one of the others must be utilized. The topography of the upper lake country is that of rugged, steep mountains. The snowfall in winter is not deep, yet deeper than in the gold districts, and blizzards are frequent. The difficulty of building and maintaining a railroad would be considerable.

At Mud Lake the country becomes flat, and is characterized by rolling hills, into which the streams have cut narrow valleys. This type of typography continues as far as Fort Selkirk, one hundred and fifty miles above Klondike, where the Rampart mountain range crosses the river. This Rampart country, with its cliffs and mountains, presents many obstructions to travel. Altogether, a railroad down the Lewes valley would be rather rough. However, there is still another pass about fifty miles northwest of the Chilkoot. It is called the Chilkat pass, and is said to be much lower than the one usually taken by the miners. It is through this that Jack Dalton, a well-known pioneer, has led a train of cattle by a short route to the gold fields. This line of travel is known as "Dalton's trail," and by it one can pass overland through a level grassy country to the confluence of the Pelly and Lewes rivers. The time necessary for making this trip on foot is said

LAKE LINDERMAN, LOOKING NORTH.

Drawn from a sketch made on the ground by the author.

to be only fifteen days, and it is thought that this, the most direct route of all, may become the main line into the interior.

Besides the ways mentioned, various others have been suggested; the route up the Stikine river, crossing overland to the Yukon from Telegraph creek, is perhaps the best of these, since it is open as late as October, while travel by the others becomes dangerous by the first week of September. Another route from the east through Northwest Territory to the Mackenzie river, thence westward to the Porcupine and down to the Yukon, is said to be contemplated by a Canadian company. This, however, would be a long route, and would lose the advantage, possessed by the Stikine line, of passing through the Cassian and other gold districts of British Columbia.

The miners, however, not only look forward to easier means of entering the country, when "grub" will be much cheaper and easier to get than now, but dream of wagon roads from the towns to the diggings. When these are put through, they will no longer be obliged to "pack" their outfits on their backs and carry them through mosquito-infested swamps, or to tow their boats a hundred miles against a rapid current. While such a condition is still in the dim future, it is within the limits of possibilities. The move has been made in the right direction, and in a few years Alaska may not be so bad a place to live or travel in.

THE PRESENT STATUS OF THE HORSELESS-CARRIAGE INDUSTRY.

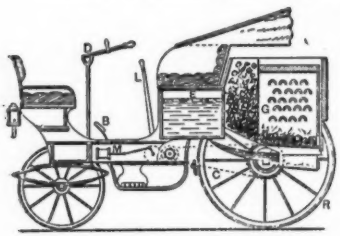
By W. Worby Beaumont.

THE motor-car industry in Europe to-day affords a remarkable illustration of the great distance or difference there may be, and usually is, between a "good makeshift" and a thing which is so far on the road to practical perfection that possible improvement is not obvious on inspection. The difference may be only in finish, or in those matters of design which affect appearance; it may be in imperfections of essential mechanical parts; it may be in both. In the motor car the difference has been and is chiefly in mechanical imperfection. When attention was widely directed to the motor cars of Paris by the races organized by the *Petit Journal* in 1894, the makeshift stage was reached. In 1896, when the Paris-Marseilles race was run, the good makeshift stage was approached, and may now be said to have been reached. With the carriages of several makers, journeys at considerable speed and of long distances were not only possible, but possible under very trying conditions as to roads, hills, and weather. These carriages, nevertheless, were susceptible of much desirable improvement, or were open to several objections. These objections were obvious, but the means of removing them were far from being so. Invention was and is necessary to their removal by means in themselves unobjectionable.

Meanwhile the motor carriages made by several firms realized the chief aims of their construction,—namely, to carry people or goods at a desirable speed. To many who want to be carried or have goods carried, the accomplishment of these aims is of the first importance; to others the imperfections outweigh this importance, and these others are mostly critics, who would rather forego, and cause others to forego, the advantages of the motor car than tolerate its imperfections. They had rather leave work undone than perform it with a good makeshift tool. This attitude of mind has done immense harm in England by delaying the progress of the motor car, just as in other days it delayed the introduction of railways and machinery,—the compound engine, the triple-expansion engine, and high-pressure and traction engines,—and would even now cause us to be without railway communication in and around London, because the engines smell and smoke and the trains make a noise, cause some vibration, and run on unsightly viaducts. Business men, however, seize upon the useful

and encourage improvement and the gradual removal of objectionable imperfections. They reap the advantages of the good makeshift, thus profitably covering the long distance that separates it from the thing which the designer ceases to improve, and at which the irresponsible critic ceases to cavil.

Much as was accomplished in England in the ten years ending in 1834 in the construction of steam coaches, it has remained to the French to bring attention to the advantages of motor vehicles for use on common roads.



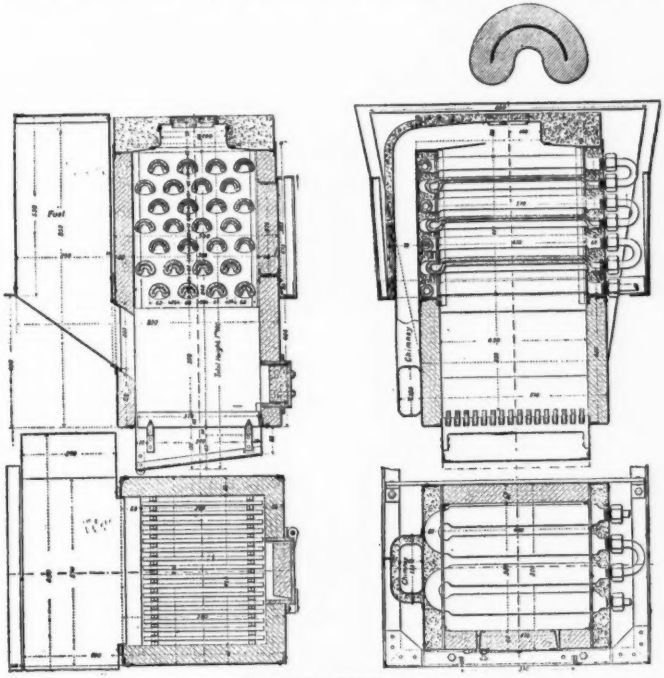
SERPOLLET STEAM CARRIAGE (1895).

The Engine in the 1897 pattern Serpollet victoria is vertical, and is placed by the side of the generator. A, generator; M, engine; L, hand-pump for injecting water before engine starts; E, water tank; B, brake; D, steering and stopping handles; C, chains.

Serpollet, Scotte, Le Blant, de Dion, Bollée, and others brought forward steam vehicles of different forms, the peculiar advantages of the Serpollet generator making it the special object of attention in 1891. In that year not only did Serpollet make very successful vehicles, but one of them was sent to England; and it and its new steam-generator were exhaustively tested with most satisfactory results. As, however, the laws of England prohibited the use of such vehicles until November, 1896, and even now prohibit them as then made, without reversing gear, nothing was done in England. In France such things may originate, but they do not, as a rule, develop quickly into a great commercial industry. Witness the gas engine. The introduction of the light oil or mineral spirit motor enabled Frenchmen to construct and develop the *automobile*, which, without doubt, would have done in England but for its repressive laws; for the first vehicle propelled by a spirit motor was made in that country in 1883 by Edward Butler. The motor designed by Daimler was, however, the real starting-point of the recent revival of the mechanical road-carriage. It was designed as a motor for the usual miscellaneous purposes, and was applied by him at an early date to the propulsion of a vehicle; but its most extensive employment was as a boat-propeller. For this it was much used in Germany, France, and England, and the name of its inventor was widely known before the motor was so successfully applied to motor cars by MM. Panhard & Levassor, of Paris, MM. Peugeot Frères, of Valigntiny, and others.* A horizontal form of spirit motor was subsequently made by Herr Benz, of Mannheim, and was applied by him and by M. Roger, of Paris, to the propulsion of a vehicle;

*See Cantor Lectures by the author, *Soc. Arts Journal* reprints, 1896.

and the count de Dion applied a spirit motor of the Daimler type to tricycles. Before the middle of 1894 the steam vehicles mentioned, and these spirit motor vehicles, had attracted the attention of those who saw great possibilities in them, and in that year the *Petit Journal* offered numerous prizes for the best motor carriages of several kinds, with the result that in July a large number ran in trial races between Paris and Rouen. As the types of vehicles which ran in this race still hold



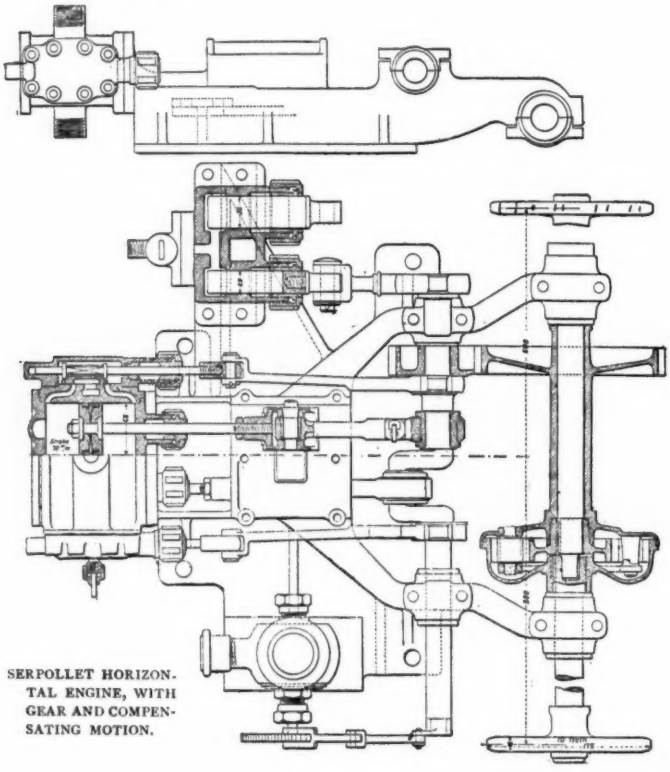
SERPOLLET GENERATOR.

the foremost position, they must be here referred to. Of 102 vehicles entered, 46 appeared for the race of 79.36 miles from Paris to Rouen These were propelled by motors of the following types:

Petroleum spirit motors, mostly Daimler, 23; steam, 12; steam and petroleum spirit, 1; compressed air, 2; compressed gas, 1; electricity, 1; various, 6. Five of these, differing in form of vehicle and in seating-capacity, were entered by Messrs. Les Fils de Peugeot Frères, and four by Messrs. Panhard & Levassor, all fitted

with Daimler motors. Messrs. Dion, Bouton & Co. sent a steam carriage for six, and a steam tractor with bogie for four; M. J. Scotte sent a steam vehicle to seat eight or ten, and M. Maurice Le Blant sent two steam brakes, fitted with Serpollet boilers and seating nine or ten persons. MM. Vacheron and Le Brun sent carriages worked by Daimler motors slightly modified, and M. Roger sent a carriage fitted with a Benz motor. The journey was made by the Dion steam tractor and carriage at an average speed of 10½ miles per hour, and at similar speeds by the Panhard & Levassor and the Peugeot four-seat carriages fitted with Daimler motors.

The prizes awarded in 1894 were: First prize, £200, divided between MM. Panhard & Levassor and MM. Peugeot Frères; second prize, £80, MM. Dion & Bouton. This vehicle was first in,



SERPOLLET HORIZONTAL ENGINE, WITH GEAR AND COMPENSATING MOTION.

but it was considered more suited to heavy work than for carriages; third prize, £60, to M. Le Blant, for his steam carriage; fourth prize, £40, divided between MM. Vacheron and M. Le Brun for improvements in details of their Daimler motors; fifth prize, to M. Roger; a sixth, or consolation, prize, £20, to M. J. Scotte for his steam vehicle, which worked well until one of the Field tubes with which his boiler was fitted burst.

Now, as showing which type of vehicle has best survived the ordeal of the French trials, and the equally valuable trials of every-day use, we must look at the results of the Paris-Bordeaux race of 744 miles for the double journey in 1895, and of the Paris-Marseilles race of no less than 1,070 miles in the autumn of 1896.

For the Paris-Bordeaux race, which was continuous day and night, only such repairs being permitted as could be done by the occupants with tools carried with them, the driver could be changed, and any vacant place had to be filled with 165 pounds' dead weight.

Twenty-nine vehicles were entered, including several steam carriages, one of which, the Dion steam drag, led for about 120 miles, after which the petroleum spirit motor carriages took and maintained the lead. A Panhard & Levassor two-person carriage completed the run in 48½ hours, an average speed of 15.3 miles per hour, but, as it carried only two, it was not eligible for a prize. All the prizes, with one exception, went to petroleum spirit motor carriages, as follows:

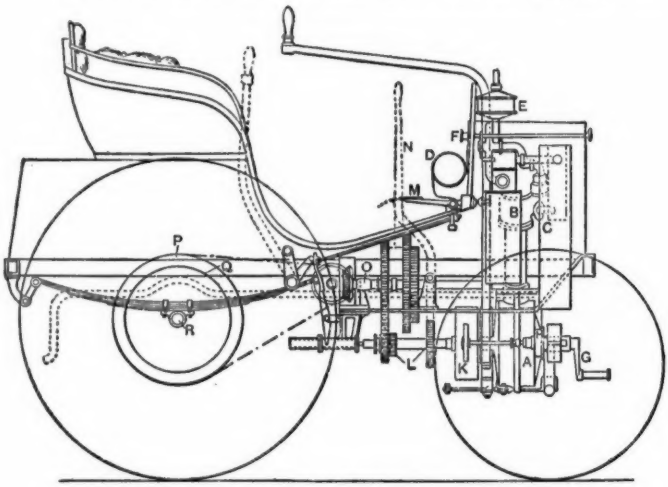
First, third, and fourth prizes, to Peugeot Frères; second, sixth, and seventh, to Panhard & Levassor; fifth prize to M. Roger (Benz motor); a special prize to M. Bollée for a steam omnibus, which accomplished the run within the maximum of 100 hours, and came in ninth. This omnibus M. Bollée built in 1880. It had a small vertical boiler 30 inches in diameter inside, with 118 Field tubes, and worked at 140 pounds.

Before referring to these vehicles in detail, the evidence of fitness by survival, after ordinary every-day use and further and even more severe race trials, must be examined. Between the Paris-Bordeaux race in June, 1895, and the Paris-Marseilles race of 1,070 miles in September, 1896, a year and a quarter elapsed. This, for men who had had all the preceding experience with petroleum spirit motors, steam, compressed air, and electricity, gave opportunity for long thought. Prizes for three types were offered,—namely, (1) vehicles with two, three, or four seats; (2) vehicles with more than four seats; (3) motor cycles.

In Class 1 all the vehicles entered, and the prizes were won by those propelled by petroleum spirit motors. In Class 2 three steam

carriages were entered, two by MM. Dion & Bouton and one steam omnibus by MM. Chasseloup & Loubert. In Class 3 five motor tricycles were entered, three of them by M. Dion.

The results of the Paris-Marseilles race, which was not run during the nights, were as follows. In Class 1 first, second, and third prizes went to Panhard & Levassor, who accomplished the 1,070 miles by three vehicles in 67 hours, 42 min., 58 secs.; 68 hours, 11 min., 5 secs.; and 71 hours, 23 min., 22 secs., respectively, or a mean speed for the three vehicles of 14.1 miles per hour, and a mean speed for the fastest vehicle of 15.8 miles per hour. Fourth and sixth prizes went



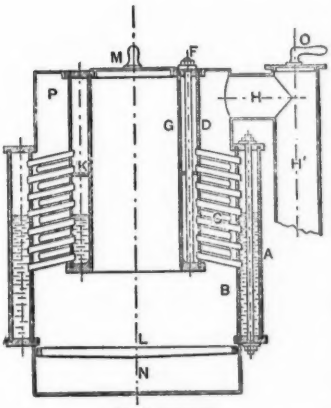
PANHARD AND LEVASSOR'S DAIMLER MOTOR CARRIAGE.

A crank box of vertical Daimler engine, B, with crankshaft carrying clutch, K, and three alternative speed wheels, L, gearing into wheels on second motor shaft, O, which drives chain wheel shaft by bent wheels and compensating gear. Chain wheels on each side, P, and brake wheels, Q. N, brake lever; M, foot control of brake and clutch; E, automatic oil flow regulator and, A, handle for starting motor.

to M. Delahaye, who accomplished the journey in 75½ hours and 84 hours 27 minutes with his two- and four-seat carriages respectively. Fifth prize went to MM. Peugeot Frères, who took 81 hours, 24 minutes. Seventh prize went to the Maison Parisienne, and eighth prize to MM. Landry & Beyroux.

In Class 2 first prize was awarded to MM. Peugeot. In Class 3 the three prizes were awarded to Dion petroleum spirit motor tricycles, one of which performed the double journey in 71 hours, 1 minute, or at the rate of more than 15 miles per hour.

The steam carriages met with various difficulties, and retired. No



DION BOILER.

A, outer shell; B, inner shell; C, radiating water and steam drying tubes connecting outer water shell to inner shell, G D. Fuel is fed in at cover, M. H, chimney.

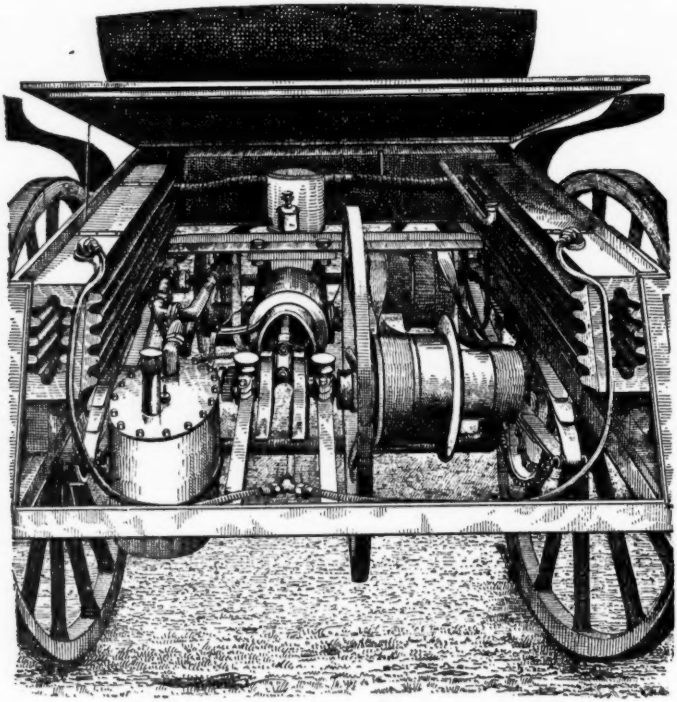
Serpollet vehicles were entered for the Marseilles race, M. Serpollet being too fully occupied in the construction of self-propelled steam tram cars, which are now so largely used on the Paris tramways. A race was run on July 24, 1897, from Paris to Dieppe, a distance of 105.4 miles. There were entered 69 vehicles, of which 55 appeared, including about 40 motor carriages and 15 motor tricycles and Bollée voiturettes. Of these 30 arrived at 4 P.M., the first starting at 9.5 A.M. The carriages included a Dion & Bouton steam brake, or wagonette, capable of carrying about ten people, including driver and attendant. This vehicle is fitted with one of the count de Dion's boilers, working at a pressure of about 240 pounds per square inch and capable of 15 to 16 h. p. and even more for short periods for mounting hills. The engine is of the Dion-Bouton type, and will propel the vehicle at any speed up to 35 miles an hour, and did the run from Paris by St. Germain to Dieppe at a mean speed of about 25 miles per hour. It runs with great steadiness, and even at the high speeds steers with the greatest precision.

The larger number of the mineral spirit motor vehicles were entered by MM. Panhard & Levassor; two however, were entered by M. Delahaye, and two by Peugeot Frères, one of which, a Victoria, had just arrived from Varsovie (Warsaw) *via* Belgium, the owner doing the 1,800 kilometers in 10 days. This carriage had run 700 kilometers before it started from Varsovie, and, after it had done about half the run from Varsovie, a total of 1,600 kilometers, new chains were put on, no other repairs or renewal of any note being made. These chains run unprotected from the dust and mud, and would probably run three or four times the distance.

M. Gauthier Wehrlé also sent some new carriages, including a very convenient little wagonette for four. The motor in these vehicles is a spirit motor. MM. Landry & Beyroux sent vehicles with vertical spindle cylinder motors, which worked well, and MM. Bollée also sent two spirit motor carriages driven by gearing with skew teeth instead of by chains. The Bollée voiturettes and Dion tricycles per-

formed most excellently, although some of the voiturettes are rather noisy, the noise arising from the powerful exhaust and the gear,—no wonder, considering the tremendous speed (25 to 30 miles an hour) these vehicles make.

M. Roger also sent carriages of his make, with the well-known Benz motor, and M. Mors sent two with his four-cylinder motors.



REAR VIEW OF ROGER VICTORIA AND BENZ MOTOR.

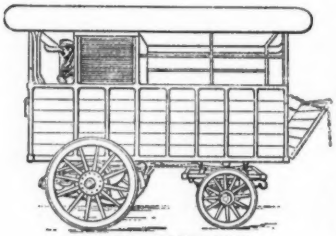
From all this it will be seen that the victory has been almost entirely, year after year, with the carriages propelled by mineral spirit motors. It must, however, be noted that most of the prizes have been offered for, and have gone to, carriages carrying from two to four people. When larger numbers have had to be carried, steam has done good work, but only a few of the steam carriages have been small and light enough to run under the conditions which the oil motor vehicle is competent to meet. M. Serpollet made a number of excellent victo-

rias, but their weight, although less than that of other steam carriages, was more than that of the oil motor carriages. This alone, although the variable power of the steam, and especially in the Serpollet, is a most valuable qualification for good and bad road-travelling and hill-climbing, has given the light oil motor carriages every advantage. Every adverse condition of running at high speeds on common roads increases enormously with increase in weight. As soon as the weight is above that at which rubber tires can be used, speed must suffer a reduction of 30 to 50 per cent.; else wear, tear, breakage, and loss of power will result, with attendant discomfort for riders. The lighter Serpollet victorias of the type most recently made are light enough to be fitted with rubber tires. They weigh only about 1,500 pounds, and, as they offer the many advantages of steam, they will probably remove many of the objections raised against the oil-motor-driven vehicle.

The experience in England with the lighter types of vehicles propelled by mineral spirit or oil is limited in comparison with that of the French,—not perhaps one-fifth. So far as it has yet gone, it has only confirmed the facts proved in France,—that the carriage driven by the mineral spirit-motor is a very excellent makeshift, and, as now made by Panhard & Levassor, Peugeot Frères, Roger, and Delahaye, very difficult to improve or to describe as open to obvious improvement. They may be open to obvious objections, including vibration when the carriage is standing, and occasional smell of incompletely-burned oil when frequent stoppings and startings are imposed by street-traffic conditions; but both these are objections which are lessening with almost every carriage that is built, although the means of their complete removal cannot be specified off-hand. In the early days of locomotives coke ovens had to be put up as part of every great railway establishment, because for years they could not burn coal. The way to get over this difficulty could not be discovered in the hurry of a few months, but, after some years of every-day use of locomotives, the difficulty was removed in the simplest manner, the locomotive being used all the time, but denounced by every critic, whose useless and obstructive part is followed by similar critics of to-day concerning motor carriages.

There are now running in England a number of mineral spirit motor carriages and motor vans made in England, and with Daimler, or Benz, or similar motors; and their success is undoubted, although improvements will be constantly made.

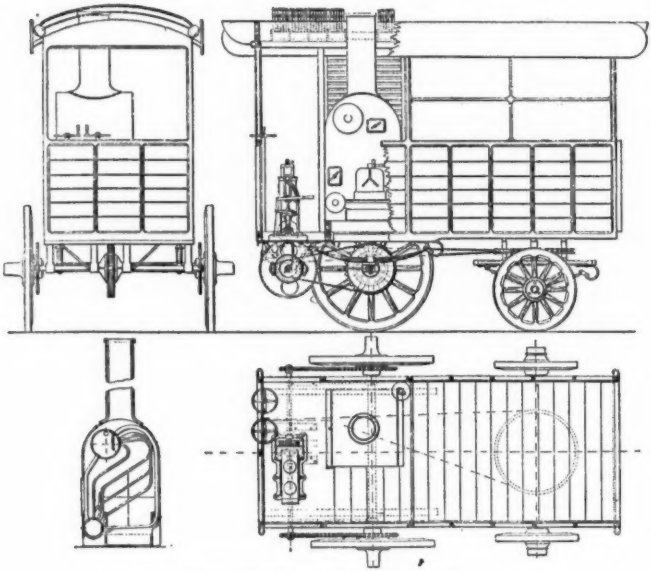
The construction of motor vehicles is already a large industry in France,—an industry which would be much greater if the French were greater masters of the art of organizing and main-



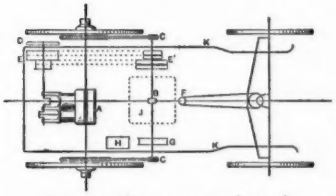
THORNEYCROFT VAN.

taining energetic manufacturing development in new lines. Certain types have survived, and the processes of selection and rejection which have preceded this survival have taught useful lessons.

Of the Serpollet steam vehicle, which was earliest in the recent renaissance of the mechanical road-vehicle, it is not necessary to say much, for it is well known. The generator is the key to the whole of the remarkable success of the Serpollet for tram-car purposes in France. It is made of tubes of crescent section and with an interior space of not much more than capillary thickness for the small boilers. Water is forced into these tubes in series, by a pump worked by the engine, the pump working against a loaded valve. The two lower rows of tubes nearest the fire receive the water from the pump all the time the engine is running, but, if the pressure in the boiler is sufficient, the loaded valve and its connections permit the water to return to the water-tank, and in this way the lime deposits are constantly removed.



THORNEYCROFT STEAM CARRIAGE.



DELAHAYE'S CARRIAGE (PLAN).

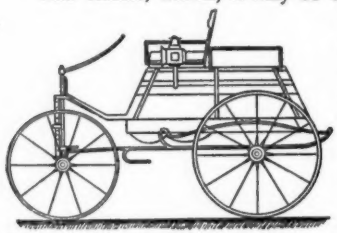
Although it might be expected that the boilers would soon be clogged with the incrustating deposits, this is not the case, and an occasional washing out with a dilute solution of hydrochloric acid of 1 to 7, which can be done in five minutes, is all that is required in any case. The advantage of this generator is that it makes no steam when none is required, and needs no attention from the driver, who has no fear as to water-level and none as to steam blowing-off at a safety valve when the vehicle is stopped in the streets. The engine of the Serpollet motor carriage, as of the tram cars, was of horizontal form, but in the most recent form of small steam victoria M. Serpollet is using a small double-cylinder vertical engine, and a vaporized liquid-fuel burner is being experimentally used, superior to the Longeunial burner which M. Serpollet had been employing instead of coke.

The de Dion & Bouton boiler and engine are practically the same as those so many times illustrated and described. (See the writer's Cantor Lectures, Society of Arts, 1896, and paper before same Society, 1896.) It is one of the high-type boilers of small content compared with heating surface, and one the water-level of which and the pressure gage of which must be under constant attention.

It is not pretended even by the count de Dion that this type of boiler will suit the requirements of vehicles of the victoria or brougham classes, which receive the attention of only one person,—namely, the driver. For these vehicles the steam generator must automatically vary its activity by simple means, in accordance with the work the motor has at any moment to perform. This is one of the points that very extensive experience may be said to have definitely proved. A light carriage cannot provide room for a boiler attendant, yet this is absolutely necessary for any form of steam generator which does not take care of itself, as the Serpollet does. For the heavier vehicles, such as trade vans for goods delivery, requiring in any case two attendants, this is not of so much importance; but in all other cases, including tram cars, it is essential. On the other hand, generators carrying a considerable quantity of water and having large steam space are equally inadmissible, because of weight and size and because of all the foregoing objections, except a slightly-lessened demand for anxiously perfect stoking, or, if oil fuel is used, perfectly automatic correspondence between not only steam pressure, but steam consumption, and fuel-supply.

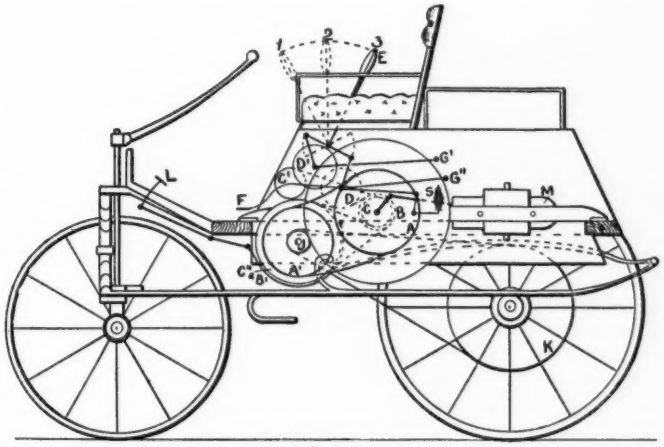
The vehicles operated by mineral spirit motors are most largely represented by those of Panhard & Levassor, which have the vertical Daimler-Phoenix spirit motor placed over the fore carriage. These are now essentially the same as in 1895, and the same may be said of the Peugeot carriage with the motor in the rear. In both the motor is connected to a second motion shaft and compensatory motion by means of three or four sets of spur gear wheels and pinions, of which one set is capable of sliding on its shaft to enable one or other of the sets of teeth to engage. From this shaft the driving-wheels are actuated by uncovered pitch chains. This form of gearing does not satisfy mechanical aspirations, but in practice it succeeds much better than could be expected, although the spur wheels are of steel and make a rattling noise. Enormous distances have been run with it by large numbers of vehicles in many hands, and renewal in this respect is very rare.

The chains, which, it may be observed, are not now so scanty in dimensions as those which some of the makers were wont to use, need renewal much more frequently than will be necessary when the constructors have found out how to make an easily-fixed, detachable, fairly dust-tight gear-case. This, of course, is not the simple problem that it is with a bicycle, as the vertical movement of the road wheels is not coincident with that of the vehicle; but, when makers and owners no longer fear to make their chain less accessible, the gear case will be forthcoming. In the beautifully-furnished brougham of the baron de Zuylan the chain is partly covered.



PETTER AND BOLLES' 4-WHEEL DOGCART.

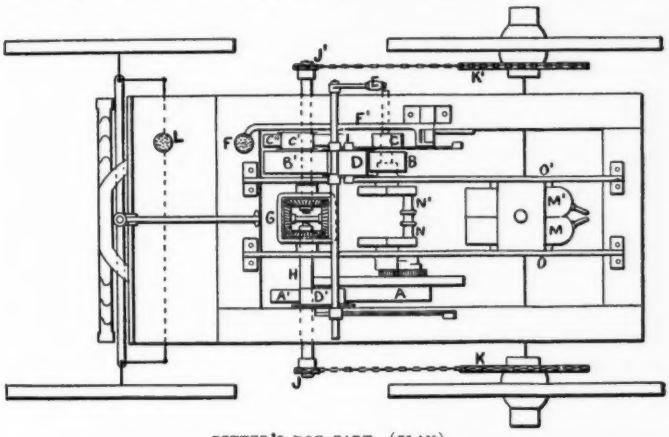
In many of the vehicles, including those of Delahaye, Mors, and Roger, the motor drives the second motion shaft by means of crossed leather belts, except that required for reversing. Two sizes of driving and driven pulleys are used, and speeds between these for manipulating in traffic are obtained by putting the belts more or less on the fast or loose pulleys. This again does not appeal successfully to the mechanical mind, but it appears to satisfy practical requirements until something better shall be found, and, after all, it is as good as the slipping or tight leather belt for hoisting which has been successfully used for generations in flour mills and elsewhere. The ordinary carriage brake, with a block rubbing on an iron tire, well supplied as it always is with excellent grinding sand, is a mechanical barbarism



PETTER'S DOG CART.

as compared with the electro-magnetic brake, in which the resistance is afforded by the invisible distortion of magnetic lines of force. But the common brake block is a good makeshift.

The spirit motors used by Roger—namely, the Benz—are of the single-cylinder horizontal type, with electric ignition, and these have



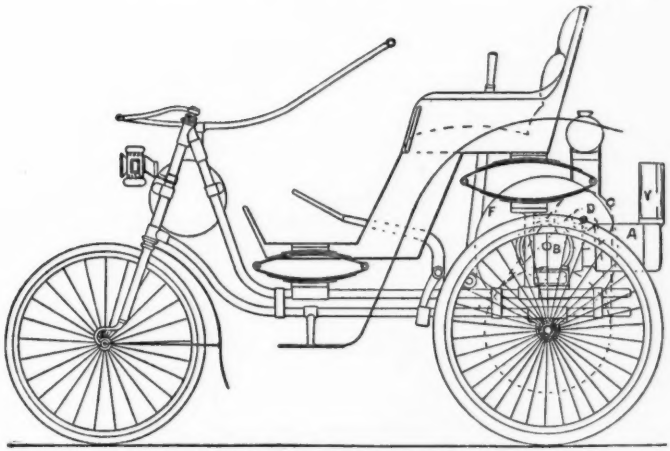
PETTER'S DOG CART, (PLAN).

M M', double cylinder motor ; N N', crank-shaft ; A A', forward high-speed belt pulleys ; B B', forward low-speed ; C C', reversing belt ; E, lever working jockey pulleys D D'. G, compensating motion ; F, reversing motion lever.

not been much modified lately. The Maison Parisienne sent a wagonette driven by a double-cylinder motor, the cylinders being on opposite sides of the crankshaft, but connected to two cranks at ninety degrees, so that, although not in line, they nearly balanced each other in the main direction. This motor ran very steadily, and the carriage was very quiet when standing with the motor running; it is, however, rather a heavy carriage. M. Bollée uses a double cylinder motor for his new carriages, and Leon Bollée would probably have distanced the Dion steam brake on July 24 but for the breakage, already mentioned, of a small rocking lever which opened the two exhaust valves alternately. This breakage incident suggests a reference to a mistake of common occurrence in the design of the small pieces having a high-speed rocking or angular movement,—namely, making them light because the work they have to perform is apparently light. A rocking lever may have to push a valve stem against the resistance of, say, a five-pound spring of an engine running at seven hundred revolutions per minute. It has to overcome this resistance in perhaps one-fortieth of the period of one piston stroke, or in about one-nine-hundredth of a second, and, if it works two valves of a double-cylinder engine, it does this seven hundred times a minute, and is jerked backward and forward fourteen hundred times. It is obvious without any calculation, therefore, that such a piece needs an enormous amount of strength.

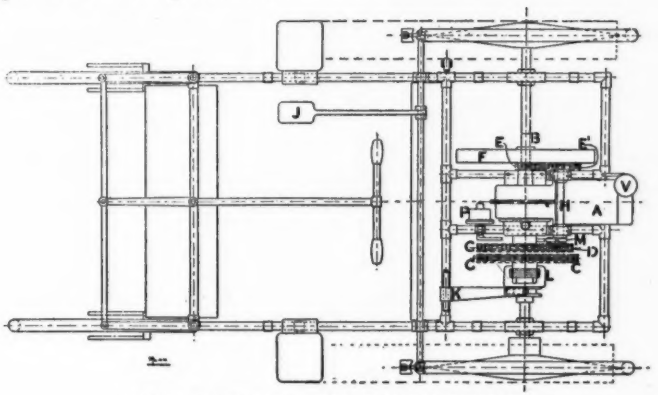
The vertical cylinder engine offers advantages which are considerable when the engine is mounted on the forecarriage, as is the Daimler, or Daimler-Phoenix, in the Panhard & Levassor carriages. It is easily accessible on three sides, and might be made to cause less vibration of the carriage when standing by complete balancing of forces in the vertical direction, leaving the consequent out-of-balance in a horizontal direction to be dealt with in another way. The four-cylinder engine of the Mors motor has advantages as to reduction of vibration, but it is desirable to lessen the number of parts.

In England one of the objections most strongly urged against the motor car is the smell from the products of combustion or from the heated mineral spirit. On this subject it must be noted that most of the makers, though not those who have made the largest number (if the Dion tricycles are omitted), use carbureters. By this means the chances of incomplete combustion and the heating and exhaust of unconsumed charges of oil are avoided, only a vapor charge ever passing to the cylinder or to the passages between carbureter and cylinder. This, no doubt, offers an explanation of the fact that very little smell is ever noticeable with the carriages or the Dion tricycles fitted in this way. However good the governing or the oil cut-



ROOTS & VENABLES KEROSENE MOTOR CARRIAGE.

out of a motor using the oil direct, there must be occasional remnants of charges or excess, when frequent stopping and starting are necessary. The automatic induction spray-making device of the Daimler-Meybach comes probably the nearest to a satisfactory means of dispensing with the carbureter, and this is adopted in England with results which satisfy every one except the most exacting. A different device is adopted in a promising light motor carriage by Duryea, but practical tests are yet wanted.



ROOTS & VENABLES KEROSENE MOTOR CARRIAGE.
A, engine cylinder; V, vaporizer; C C', driving chains; E, valve gear chains.

Only two makers—namely, Roots & Venables, of London, and Petter & Boll, of Yeovil—have so far attempted with any success to use motors worked with kerosene or high-gravity and high-flash-point oils. The difficulties as to vaporization, starting, and smell not only of exhaust products, but of partly-burned charges during stopping and starting, are much increased, and the success is of a very qualified character. One of the two makers referred to, both being English, prefers the mineral spirit motor.

Most of the large number of vehicles shown in Dieppe on July 24 and 25 were fitted with wood wheels, all having rubber tires and many having pneumatic tires. The limit of weight for pneumatic tires has probably not been reached, but experience so far seems to show that, for the high speeds frequently run in France, the limit is soon reached, and four hundred pounds per wheel is perhaps the maximum economical load even at moderate speeds. The Michelin tires used in France seem to stand well, except as to the cutting, which increases rapidly with increase of speed above eight miles an hour. Solid rubber will cut at least as much, but the effect is not so serious. The weight per wheel on rubber tires of any kind for high speeds is an important matter, for no pleasure-carriage can be considered satisfactory unless on rubber tires.

Iron-spoke or cycle wheels are used only by one eminent firm,—namely, Peugeot Frères,—the general opinion being in favor of wood. This is largely based on experience as to the durability of the wheels and their tires, but it is partly due to the facility the wood wheel spokes afford for the attachment of chain rings. For all vehicles, however, up to perhaps two tons' weight, the wood wheel will continue to offer the advantages of strength and a useful amount of elastic flexibility.

The question of relative economy of the different oil motors can hardly be said to have received much consideration. The cost per mile of running a carriage carrying four is so small that a little more or less is of no importance. Taking average roads, the consumption is not more than three or four pints per hour, and in this time twelve miles will have been easily run, so that the maximum cost per passenger per mile will be under a half-penny.

It is possible that within a year the industry, which is a real one in France, though limited to a very few makers yet, will be a greater one in the United States and the United Kingdom, but it will find most support first in the construction of business vehicles, such as vans and lurries.

THE EXTENDING USE OF GAS IN INDUSTRIAL OPERATIONS.

By Frederick H. Shelton.

THERE are about a thousand towns and cities in the United States wherein a total of approximately 60,000,000,000 cubic feet of illuminating gas is annually manufactured. This gas is used chiefly for lighting, largely for domestic cooking and heating, and to a moderate extent for power purposes. A very considerable proportion of it, however, is used—and to the very highest advantage—in place of coal, as fuel for purely mechanical and industrial purposes. That probably a similar volume of various kinds of gases other than illuminating gas is also made and used, wholly for industrial purposes, is not generally known, excepting to those whose business it is to be informed upon such matters.

It is my purpose to point out the great number and variety of uses to which gas is now applied in the arts and manufactures. Within the limits of a magazine article it is impossible to go into the details of the relative operating cost of gas as compared with other fuels, or of the exact nature of all these increasing applications. A bare enumeration of the principal uses may, however, attract the attention of consumers of hard fuel and lead them to appreciate more fully the advantages of gas fuel.

In the main heat has hitherto been secured from coal, which, while effective, is relatively cumbrous and inconvenient to handle. If coal could be conveyed as a fluid, from a central point, through suitable distributing pipes, to the various points of use, precisely as is water, steam, compressed air, oil, brine, or other fluids, the advantage, convenience, and desirability—disregarding cost for the present—would be obvious to every user. Assume this possibility, and that in many instances "fluid coal," so to speak, is cheaper than ordinary solid coal. From the industrial standpoint gas is simply fluid coal, or fluid fuel. Its use saves time, increases output, betters the quality of goods, eliminates ashes and heavy stoking labor, enhances convenience, and decreases expense. Small wonder, then, that it is extensively used and that such use is constantly increasing.

As popularly understood, "gas" is an invisible fluid served from pipes, which in burning gives off both light and heat. There are, however, several well-defined kinds of commercial gas, differing widely in their characteristics and heating power. The principal

ones are: natural gas; illuminating or city gas; blue or fuel water gas; oil vapor in various forms; and producer gas. These five comprise all the gases used by manufacturers at large to any considerable extent for fuel. Typical analyses of these, exclusive of oil vapors, are as follows:

	Natural gas from Findlay, Ohio.	Illuminating gas. Samples exhibited at Gas Exposition, N. Y., February, 1897.		Blue or Fuel Water Gas.	Soft Coal (Taylor) Producer Gas.
		Water Gas.	Coal Gas.		
Hydrogen	2.18	32.7	48.1	50.9	12.00
Carbonic Oxid	.50	30.2	7.6	44.5	27.00
Carbonic Acid	.26	2.4	0.3	2.45	2.00
Marsh Gas	92.60	16.8	36.5	.....	2.50
Illuminants	.31	14.4	4.3	.....	.. . ..
Oxygen	.34	0.4	0.4	0.07	.. ..
Nitrogen	3.61	3.1	2.8	2.08	56.50

Commonly spoken of as gases, these are really only combinations —practically definite and constant—of certain other gases, such as hydrogen, carbonic oxid, marsh gas, etc., as may be noted. As these component gases have each a well-defined heating value, the calorific power of any mixture of them (such as one of the above tabulated commercial gases) is readily determined by finding the nature and proportions of the component gases, and then aggregating their heating values. For instance, marsh gas is theoretically one of the greatest heat-producing gases, and naturally gas, being principally composed of marsh gas, proves in practice to have the highest heating value of all commercial gases. It is obvious that the gas having the greatest heating-value is, other things being equal, the most useful as fuel in mechanical operations. For comparisons of heating values the British thermal or "heat unit"—"that quantity of heat that will raise the temperature of a pound of water one degree Fahrenheit"—is used. Natural gas has a value of about 1,100 heat units to the cubic foot.

Natural gas is thus mentioned in order that its great heating power may be noted in figures, in comparison with the artificial gases, of which more extended mention will be made, rather than merely to specify the uses to which it is applied. These uses, of natural gas, while many industrially, are only those to which other gases can be applied. To the mind of the writer, the substitution for hard fuel of natural gas, intensely rich, costing but little, and conveniently supplied under pressure is not a measure so progressive as to call for

special commendation. It is certainly nothing in comparison with the skill and invention necessary to successfully and economically make and supply an artificial gas that advantageously displaces solid fuels previously used. To note the success that has been achieved in the use of artificial gas fuel is the especial object of this paper.

Illuminating or "city" gas, as made by the water-gas process, is the nearest approach to natural gas, in calorific intensity, of any of the manufactured gases. Made by the decomposition of water, it is chiefly composed of hydrogen and carbonic oxid, both of which gases have a high heat-unit value. When these are enriched by petroleum vapors to form an illuminating gas of 25 to 30 c. p , the resulting compound has an aggregate heat-unit value of about 725 to 760 per cubic foot. This, the best commercial gas that man can make, is yet, it will be noted, but two-thirds as rich in heating power as natural gas, which so far man has been unable to reproduce on any commercial lines. Illuminating gas, as made by the coal-gas process, is gas distilled from rich bituminous coals in retorts, and is composed principally of hydrogen and marsh gas. As served to the public, its heat-value is about 630. This carburetted hydrogen, however, whether made by the coal-gas or the water-gas process, is primarily made to give light. Richly laden with hydro-carbons and illuminants, its manufacture, purification, and distribution are expensive, and it cannot be sold by gas companies at a figure low enough to warrant its general use for heating in mechanical or industrial operations, except where the cost of the heat involved in an operation is but a small proprotion of the total cost. Its use is practically limited to light operations, where quality and convenience rather than volume of heat are essential. As the variety and number of such operations are very great, an enormous actual amount of city gas is, after all, used in commercial pursuits. One of the simplest of these applications is heating air. In ventilation a current of air may be conveniently induced by burning city gas in a flue. In dyers' and cleaners' drying-rooms, in tobacco-seasoning-rooms, in drying druggists' preparations, in the warming of lithographers' stones, etc., where a gentle heat is required, city gas is often the agent employed. The ripening of bananas by heat from city gas is common in the fruit trade. Equally common uses are the warming of liquids and melting of metals. In drug and grocery houses gas is used for the heating of vats, kettles, etc. Plumbers so use it in the shop for melting lead and solder. In large printing-houses it is used for keeping type-metal liquid in linotype machines, and for melting gelatin for ink-rollers, etc. In bottling works caustic solutions for cleaning bottles are kept hot by gas. The heating of irons is a common use. Both hand-irons and the rolls

of power irons are warmed by gas in laundries. Branding plates, irons for marking boxes or for stamping corks, and polishing irons in various trades are conveniently heated by gas. In the more strictly mechanical operations, hard soldering or brazing with the blow-pipe is very extensively done with gas. In the jewelry and silver ware working cities, of which Providence is typical, no mean proportion of the gas company's output is used in the shops for the soldering, tempering, case-hardening, and annealing small tools, dies, cutters, etc., and in the hundred and one small operations requiring heat. In other directions the uses of city gas seem endless. Dentists use gas in bunsen burners for warming and for softening cavity fillings. Express companies use it for melting sealing wax—an apparently trivial, yet strictly typical, instance of its convenience. Gas-fired ovens for firing decorated china are common. The metallurgist uses gas in assaying. Small tools, springs, and scores of other metal objects are made by gas heat. Hat factories use it in working felt, and shoe factories are large consumers. The filaments of incandescent electric lamps are baked by city gas in some instances. Bakers, confectioners, and restaurant-keepers constantly use it in their industries. Bicycle-makers use it for liquifying japans and enamels, and for brazing, annealing, hardening, etc. And so the list might be extended *ad infinitum*.

One important use is in water-distilling equipments for private houses. The increasing demand for pure drinking water has brought into the market gas heated stills for this purpose.

"Blue" or "Fuel water gas," or uncarburetted hydrogen, is the gas made in the first step of the manufacture of illuminating water gas. Composed almost entirely of hydrogen and carbonic oxid, it burns with a clear, blue, smokeless flame, and has a heating value of about 300 to the cubic foot. For mechanical purposes the gas is excellent, and it is simply and cheaply made. Commercially, however, the efforts to make and distribute it to the public at large for heating and industrial purposes have been unsuccessful. The reason is that, while "blue gas" is cheaper to make, its distribution costs as much as that of city gas, and, with its heating value but half or less (owing to the omission of the rich hydrocarbons or oil vapors), it has had to be sold at prices that have not repaid the makers. Even when sold at but half of the price of city gas, it proves, on the whole, to be still as costly *per heat unit*, and is, therefore, limited, like illuminating gas, to small operations. The plant for making it, however, is comparatively simple, and in numerous cases manufacturers who could not afford to buy either city or blue gas of another have yet found it practicable and economical to put in individual plants to make their own supply, thus saving the cost of distribution, and management, and the

profit. They thus obtain a gas of good heating value, clean and complete in combustion, easily piped and applied, and low in cost. For practically all the industrial purposes for which city gas is used, and kindred ones where small or moderate volumes of heat are required, it gives satisfaction mechanically, and often secures a marked economy over hard fuels. Many private plants are using this gas. Probably its most typical use is in factories where metal-working in many small forges is conducted upon a large scale, as in cutlery works, for which purpose it is an ideal fuel, vastly superior to coal. With coal there is the liability of unevenness of fire,—causing irregularity of goods and loss of time; with gas, there are no ashes to handle, and if the forges or furnaces are lighted half an hour before starting up, all will be at proper heat and continue so throughout the day. The work per forge or man is increased; time is economized, and "seconds" are decreased; cost is lessened, and the quality of the product usually bettered. In such work the gas is principally used in ovens or furnaces, which are simply fire brick-lined iron boxes, mounted on stands of convenient height, for drop forging, annealing, tempering and hardening, case-hardening, die making, etc. Blue water gas has also been used for years in the largest saw and file works in the country, and particularly in watch works. In the latter it has proven peculiarly suitable for delicate work, such as the annealing and tempering of fine springs, the enameling of dials, the melting of gold, silver, and platinum, fine blow-pipe work, etc. An interesting instance of the perfect suitability of gas fuel for many specific and unusual purposes in industrial operations is the use of blue water gas in one of the large New England bleacheries for singing the nap from cotton cloth. The old way involved the use of a heavy copper cylinder, revolving over a bed of coals that kept it hot. The web of cloth was rapidly moved over it, from one roller to another, in such a way as to graze the hot copper roll, tangentially. The momentary contact burned off the nap, but was also liable to burn holes in the cloth by fuel specks carried up, etc. The copper rolls were expensive, and warped and cracked in use, involving frequent re surfacing. The substitution of gas has made a perfect arrangement. In place of the copper roll, a finely-perforated gas pipe is now used; a row of minute gas jets supplies the requisite line of flame for singing the passing cloth, and the cumbrous coal bed and cylinder are things of the past.

Blue or fuel water gas has also been considerably used in foundries, iron and steel and glass works, etc., for drying cores and flasks, plate welding and reheating, crucible melting and other purposes. Such industries, however, tend towards the use of large quantities of heat,

and, while mechanically the work may be well done, economically it approaches the conditions wherein producer gas may be the cheaper to use. For drop or trip hammer forging, or other small high-temperature forge or furnace work—in rivet, rod and nail machines, in pipe bending and all operations of similar magnitude, blue gas is at its best.

The use of "oil gas" or some form thereof, owing to the cheapness of petroleum and naphthas, has in recent years made very considerable progress in the arts. The term is elastic. The true oil gas, made from petroleum vaporized in retorts by heat, is a chemically-fixed illuminating gas of very high candle power, with heating value unnecessarily good, and too expensive for mechanical operations. As ordinarily understood, "oil gas" is merely a mechanical mixture of air with oil vapor. A current of air is passed over or through suitable volatile oils, picking up so much vapor that the transportable mixture will burn with a moderate light and high heating effect. The Springfield gas machine for lighting isolated country houses is an old, though perfect, type of this. The "gasoline gas" or "greased air" product, as so made and popularly named, has practically all the characteristics and advantages of a gas, and for convenience sake is so designated. Apparatus for making it has been so perfected of recent years by the use of proper mechanical devices for ensuring the uniformity and reliability of the product that to all intents and purposes such apparatus has become the equivalent of individual factory gas works suitable for affording a fluid fuel-supply that will in many cases do the work done by natural, city, or blue gas, and with equal satisfaction and economy. Many such plants have been installed, particularly by metal-working establishments, isolated from the use of the so-called regular, or true, gases. While for a trifling amount of heat it would not pay to install a plant for its manufacture, and for large operations the cost of any form of oil gas would exceed the cost of producer gas, there is yet an enormous field of medium mechanical operations for which it is suitable. Those applications already mentioned, involving high-temperature work on a small scale, are representative. The manufacture of sewing machines and bicycles involves many specific applications. Dial and enamelled novelties, and gun work, where drop forgings are a principal feature are other specific instances. Other applications are the manufacture of rouges and polishing compositions; the melting of copper in brass foundries; the manufacture of dentists' tools and of artificial teeth; muffle work; assaying and refining gold and silver; "sweep reducers" melting; and blow-pipe work.

The heating value of the various oil gases differs widely, depending largely upon the design and efficiency of the producing apparatus.

As made from naphtha on a high-grade, typical, modern machine, its value is about 300 heat units per cubic foot, or about the same as that of blue water gas.

"Producer gas," by far the lowest in heating value of all commercial gases, presents a great contrast between its apparent relative worthlessness as compared with other gases, and its actual value for magnificent fuel economies in the largest manufacturing establishments, where its virtues are known and utilized. As ordinarily made, it has but one-fifth or one-sixth the heating value of city gas, or but 120 to 135 heat units per foot. More than one-half of it is incombustible nitrogen. It is utterly useless for illumination. It is so dull and inert that it cannot be easily lighted or burned if it has become cooled and lost the original sensible heat of the gas producer. It cannot be used in small quantities, or conveyed through small wrought-iron pipes, or be piped around a town like other gases; and yet, despite all these apparent drawbacks, it is so cheaply and simply made, and so wonderfully effective when properly applied, that it has become the standard and only fuel in numerous industrial operations of the highest importance. These operations are at times spectacular, and always interesting. Limitations to the use of producer gas are that it must be used as made, and on a relatively large scale, and at a point practically adjacent to the place of manufacture. These limitations are not objectionable in large manufacturing plants, and many, by installing producer gas, have practically secured all the advantages of cheap natural gas. In competition with rivals in the natural-gas field, the ability thus to secure so cheap a gas fuel is often a point of extreme importance. Producer gas, made up of carbonic oxid, hydrogen and nitrogen, is merely the blue gas of incomplete combustion often seen hovering over the top of domestic furnace fires. It is purposely made on a large scale from either buckwheat anthracite or cheap slack bituminous coals. Burned as it comes from the producer, it is so low in heating energy that it cannot be so used, except where moderate furnace heats are sufficient. By preheating the air used for combustion, however, by some system of recuperation, increased temperature can be secured; and, if, by a full system of regeneration, the incoming gas and air are both preheated, as high a furnace temperature can be obtained as may be necessary for almost any kind of work. In the latter cases, moreover, for a given amount of work the amount of coal necessary, converted into and used as producer gas, is often but a half or a third that which would have to be used if directly burned. For such reasons it is by far the cheapest fuel, where large quantities of heat and white-hot temperatures are required, as, for instance, in steel works. For years it has been a standard part of such plants for firing

open-hearth furnaces, the heating of slabs and ingots, the melting of steel, etc. Glass manufacturers have also made most extensive use of it in both crucible and tank furnaces for melting purposes. That it is sufficiently efficient in this work, one can well believe when standing before a 60-foot furnace of molten glass, kept seething and surging under the radiant heat from a torrent of producer gas playing over it. In copper- and silver-mining districts,—notably in Montana,—for smelting and ore-roasting, producer gas is largely used with especially marked success as regards evenness of temperatures and economy. The same is true for iron, zinc and other ore roasting. The modern method of steel making requires the reduction of the 2½ per cent. of sulphur often present in the ore down to about ½ per cent., before going to the smelting furnaces. The process consists of driving out the moisture by roasting, and producer gas is now practically the only economical way of accomplishing it. In the firing of pottery, terra-cotta, and brick kilns, producer gas is also extensively used. In the char houses of sugar refineries, for the making of animal charcoal, it is becoming a staple fuel. In annealing furnaces in the manufacture of steel rope and malleable castings, and in brass and copper works, it is used in numerous instances. In city gas works it is often employed for firing the retorts that distill coal gas. In illuminating water-gas manufacture it is used for heating the chambers necessary to fix and make permanent the petroleum vapors used for enriching. For the manufacture of enamelled iron bath-tubs, "granite" and other enamelled iron ware, it is peculiarly adapted, giving a cheap and uniform heat for firing the muffle ovens which contain the goods.

In the Solvay Process works near Syracuse, and in other similar chemical establishments involving large operations or reductions by heat, it is used extensively. In short, wherever heat is required on a large scale, producer gas is generally the cheapest of all fuel as well as wonderfully effective and convenient.

One of its most interesting special applications is the tempering of steel guns at the Bethlehem Iron Works, South Bethlehem, Penn. The gun is hung within a vertical furnace, and upon it from all sides numerous jets of producer gas play, until the right temperature is reached. The gun is then transferred to an adjacent oil bath, plunged within, cooled, and tempered, precisely as a blacksmith tempers a fine tool. When it is stated that some of these guns weigh twenty five tons each (forty-ton ones are in prospect) and are sixty feet in length, and that both the furnace and the oil tank resemble in size the water tower of a small town, the magnitude of this industrial operation of tempering by gas may be realized.

Enough has been said to show that gas, whether of one kind or

another, is used most extensively for industrial purposes, and that its use is evidently a factor of the highest importance to progressive manufacturers alive to the necessity of securing the greatest economy and all possible advantages in their fuel operations. And yet, extensively as it is used, and constantly increasing as its uses are, it is the opinion of the writer that the number of plants in which gas is so used does not constitute one-quarter of the number wherein it can, and ultimately will, be adopted to advantage. Whether it should be adopted or not by manufacturers not yet using it, need not be a matter of vague opinion ; it is a matter susceptible of proof from practically exact figures. Hard fuel for any given heating operation now costs a certain amount. A given net amount of heating effect is secured from it, which can be closely calculated. The comparative cost of an equivalent net amount of heat secured from any one of the several commercial artificial gases mentioned is a matter of comparatively easy figuring to any one familiar with the nature of the work, the cost of the gas or gas-making materials, and the relative heating values and characteristics of the several gases. A manufacturer paying large sums per year for hard fuel who has not employed an expert to determine whether illuminating, blue water, oil, or producer gas can advantageously displace that hard fuel is certainly running a large risk of conducting his business under a handicap of unnecessary fuel expense, compared with the possible lower cost of gas. In a surprising number of cases the figures will show that economy can be secured by intelligently substituting one of the gases mentioned, to say nothing of an increased amount of product, a better grade of work, and other incidental advantages almost invariably secured.

REVIEW OF THE ENGINEERING PRESS

The Mole Antonelliana.

THIS is said to be "the tallest structure" and the "most venturesome piece of construction in the world." It forms the subject of an interesting illustrated and technical description in the *Journal of the Association of Engineering Societies* for May. The paper was read before the Technical Society of the Pacific Coast, February 5, by Mr. G. W. Percy. "The peculiarity of this remarkable work consists, principally, in its light, elegant construction, with common bricks and lime mortar, whereby a small quantity of material, and that of the most common kind, is employed to enclose a large building and carry it with safety and stability to the unprecedented height of 538 feet above the ground." Although the mortar is of the common kind, unusual care appears to have been taken in its preparation; we are told that it was made from lime slaked and buried in pits for a year or more before use. A proper admixture of sharp sand is employed in the mortar, and no cement whatever is used in the work. "The actual load on most of the supporting members is about fifteen tons per square foot, which must be largely increased at times by wind pressure. The structure is named after the architect who designed it and personally supervised its erection,—Professor Antonelli, of Novara. The building was constructed for the Israelitish University Society of Turin, and in a competition instituted in the year 1862, in which many plans were submitted by Italian architects, the design of Professor Antonelli was accepted. The design was to produce "an imposing structure, which would serve at once as a grand synagogue, college, and administration building." For the details of the design and construction the reader may consult Mr. Percy's article. One of the principal points of interest in the structure is the combination of cupola and spire, which beginning at a height of 275 feet from the ground, rises 268 feet further, and superimposes a weight of about 550 tons upon the dome proper. It is hardly necessary to add to the above that the design of such a structure demanded the highest degree of skill; the fact that it is regarded as safe by competent authorities is sufficient evidence of the competence of its designer.

The General Government Fostering Good Roads.

IN an elaborate article in *Brick* (July 15) the subject of good roads is treated: first, historically, beginning with the ancient Roman roads and their builders; second, from an engineering standpoint; and, lastly, in its present aspects in the United States. What the general government is doing to further good-road building is also set forth at considerable length, in a quotation from a letter written by W. E. Curtis to the *Chicago Record*. The department of agriculture has directed General Roy Stone, chief of the bureau of good roads, to construct and exhibit an example of a steel road at the Nashville Exposition. The use of this material for roads in regions where stone and gravel are scarce and where the soil is deep and sticky will, in the opinion of Secretary Wilson, be "the easiest solution of the good road problem" for such localities. At present prices these steel roads can be cheaply constructed. Flat, or slightly trough-shaped, bars of steel are to be used as supports for the wheels of vehicles, and, to prevent the slipping of horses, the rails will be transversely indented sufficiently to afford a foothold for the calks of horseshoes without materially affecting the smoothness of the surface for the wheel-treads. The joints of the flat bars, or rails, will be made strong enough to prevent them from giving way under use, and thus forming depressions. While forty pounds per ton is the average required to pull a load on a level macadam road, it is claimed that eight pounds will do this

work on a steel road. In this respect, however, a good brick road can be scarcely inferior to steel. It is believed that a good brick road will outlast a steel road. Another way in which the government is helping on the cause of good roads is by using the agricultural experiment stations as sources of instruction in road-building to the public at large. On this point Mr. Curtis says: "The limited funds at command have not encouraged any practical work in this direction, but coöperation has now been established by the director of roads, under which the manufacturers of road machinery furnish the necessary plant free of charge, the county or city authorities provide the material and the labor of men and teams, and the government furnishes an engineer to oversee the work and instruct students and visitors, and pay for one or two skilled operators for the machines. In this way a very slight outlay of public funds accomplishes a large amount of instructive work." Experiments with brick roads are already in progress in some of the western States. At Monmouth, in central Illinois, a road of vitrified brick set on edge in a single course on a bed of sand between oak plank curbs is now undergoing probation, and is regarded with favor. Brick trackways, with intervening gravel paths for horses, have been proposed. Where macadam roads are practicable, and under the most favorable conditions,—*i. e.*, where laborers can be obtained for seventy-five cents per day, where fuel for steam power is cheap, and where suitable road metal is close at hand,—they may be constructed and bridged for $100 per mile for each foot of width. Thus a road thirty feet wide would cost 3,000 per mile. Good gravel roads cost from $1,000 to $2,000 per mile. The material for the heaviest class of steel roads costs, at present prices, $3,500 per mile; for lightest steel roads the cost of material is estimated at $1,000. For long lines of the heavier class of roads, it is thought, the steel will ultimately cost about $2,000 per mile. Brick for road-building will cost more per mile than steel for tramways, but, taking the intermediate path for animals and the side ways into account,—for these must be well built and maintained also,—we are inclined to agree with *Brick* that a road paved from curb to curb with vitrified brick is, in proportion to its cost, the best road known to modern engineering.

Electric Production of Sodium Peroxid.

THE changes wrought by the use of electrical methods in some of the chemical and metallurgical industries are destined, we think, to be ultimately as sweeping as the changes in the mechanical arts brought about by the application of electrical machinery to the transmission of power, etc. The *Electrical Engineer* (June 23) gives an outline of the electrical equipment and installation of the Niagara Electro-Chemical Company, with illustrations of its three rotary transformers of 175-kilowatt capacity, running at five hundred revolutions per minute, which form part of the very complete outfit. The process of making sodium peroxid is extremely simple. The metallic sodium is first electrolytically obtained from molten caustic soda. The electric current is run from the switchboard to, and in series through, the pots in the pot-room, and the metallic sodium is cast into the form of bricks. "The sodium is put in regulated quantities into dishes which travel through a long tube fixed in a furnace. Dry air in regulated quantities is then passed through the tube, which is kept at a certain temperature, and the sodium is oxidized to peroxid. The peroxid comes out as a beautiful canary-colored substance, which is immediately sent to the grinding-room to be ground and packed. It will undoubtedly seem strange to some that a metal, like sodium, which a few years ago was barely seen outside of the laboratory, should be made in such quantities, be handled with such ease, and be converted into a peroxid which gradually, but surely, appears to be taking the place of barium peroxid. Both are used in the manufacture of hydrogen peroxid solution. Until recently the bleacher has been obliged to buy his peroxid of hydrogen in the form of a solution, which is bulky and likely to lose its strength; it is also difficult to keep

with it a bath of uniform strength. In peroxid of sodium, however, the bleacher has a substance which, it is said, contains twelve times as much oxygen available for bleaching as the ordinary ten-volume hydrogen peroxid solution, and which can be kept an indefinite time." The process of manufacture is continuous, employing fifty men, divided into two shifts of twenty-five each.

The Sault Ste. Marie Canal.

THE report of this canal for the navigation year 1896 shows that the total value of all freight passing into and out of Lake Superior in 1895 amounted to $159,557,129. In 1896, notwithstanding a general depression in the value of commodities, the total value of the freight passing through the canal was $195,557,129. A remarkable feature is the reduction in freights. In 1886 the freight was 2.3 mills per ton per mile. This has been reduced to 0.99 mills per ton per mile, or only about one-fifth of the freight rates now charged on the most economically-managed railways. There is a continual growth in the size of cargoes, 5,000 to 5,250 tons now being no longer exceptional. It is only a few years since a vessel carrying 2,500 tons was considered enormous for upper lake traffic. The *Boston Journal of Commerce* (June 19), commenting upon the statistics given in the report named, says: "The number of vessels plying to the port of New York or elsewhere in the ocean service, and carrying more than these ships of the inland lakes, is very small indeed, so far as bottoms owned by Americans are concerned, and, with the single exception of one line of ocean passenger ships, there is nothing to equal these newest lake fleets. While these ships are very differently modelled from those on salt water, they are every whit as substantial, and receive the highest ratings from Lloyds and other bureaus. Indeed, many of the notable recent advances in marine architecture have originated on the American lakes." It is claimed that the first quadruple-expansion engines used in the merchant marine were placed in the two express passenger steamships of the Great Northern railway, "which are scheduled for shuttle-like runs between Duluth and Buffalo at a sustained speed of twenty miles an hour, week after week." It is also claimed that the first two tubulous steam generators used in the merchant service were employed on the lakes. The western ship-builders have also devised for the peculiarities of lake service new models of steel construction for hulls, "and the channel system, in use at most lake yards for the larger ships, is supposed to be ahead of any other method for strength and saving." The improvements for handling cargo have always been enormous. One thousand bushels a minute is an ordinary rate in loading ships with grain. Ore is placed on vessels at the rate of one thousand tons an hour. Coal is shipped by the carload, the cars being hoisted and dumped into the holds of the vessels. The journal quoted thinks it not improbable that fifty million tons of freight will be moved in all the inland lakes of the chain this year.

Comparative Fusibility of Foundry Metals.

THIS subject, lying at the very foundation of the knowledge of metal mixtures in foundry work, was ably treated by Mr. Thos. D. West in a paper read before the Pittsburg Foundrymen's Association (June 28), and printed in *The Iron Trade Review* (July 1). Mr. West, as is usual with him, begins at the beginning of the subject, and points out "how easily a formulated mixture can be prevented from giving calculated results by one metal having a lower fusing-point than another when charged into a cupola." Not only to the founder of heavy castings, but to the manufacturer of light castings, this is important. Mr. West's paper gives an account of an experimental research made by him to ascertain the effects of "different combinations of metalloids upon the fusing-point of iron." Failing to find suitable appliances for carrying out such an investigation, he devised a cheap cupola, which answered the purpose. A portion of the paper is taken up with an illustrated description of this apparatus and its operation, for which the original paper must be

sought. We may say, however, that it is designed to provide for comparative tests (the assumption being that the metal which comes down first has the lower fusing-point), for separate discharge which prevents the commingling of one metal with another on the sand bed of the cupola, and for so regulating the blast—including a center blast—as to obtain uniformity of heat in all parts of the cupola area. In the use of the cupola for determination of comparative fusibilities eight men are needed: "a time-keeper; a man to charge on fuel and poke it down, so as to preserve a solid fire until the iron is about half down; one at each tap hole, to keep it open, that the metal may flow freely; and, if the metal is to be caught in molds, two men on each side to take away the filled molds and replace empty ones." Passing over a statement of the different useful applications to which such a cupola is adapted in foundry study and practical work, we come to the results of experiments upon fusibility made previous to the date of the reading of the paper. The investigation is only in its first stage, but, at the special request of the secretary of the association, Mr. West consented to make known the effect of low silicon and high sulphur upon the fusibility of iron, as compared with the carbon and iron closely constant. Other papers promised will deal with results of more extended investigations. We cannot here reprint the tabulated data of comparative fusing tests of high and low silicon and high and low sulphur irons, but we quote Mr. West's remarks upon the tables. After stating that the drillings for analysis were all taken from the blocks as they came from the first casts of the original pig or scrap metal, he says: "In all the 'heats' the hard iron is seen to come down first,—excepting one case, which is found in heat No. 6,—and that the flow of hard iron ended soonest in all the heats. Thus, as far as these tests go, they show that hard iron will melt faster than soft iron. While I desire to reserve for my next paper any comments as to cause and effect in relation to the chemical composition of these irons, I will say that the irons used correspond in their analysis to irons employed in general founding. . . . I am of the opinion that we can have a combination of the metalloids wherein the softer iron would be the first to melt. . . . And I believe the day is coming when we shall consider reliable data upon the comparative fusibility of our irons to be often of as much value as a knowledge of their chemical constituency." Mr. West outlines further research contemplated by him in this new line of investigation.

Sewage-Filtering for Small Towns.

ENGINEERS who are engaged in designing filter beds of very moderate capacity may gain some useful hints from an illustrated detailed description of filter beds designed by Charles W. Leavitt and constructed at Essex Fells, N. J., which is printed in *The Engineering Record* (July 3). "These filter beds are used to dispose of the sewage (about 20,000 gallons daily) of an improved residence district. They have been substituted for a system in use several years, constructed at small cost ($2,000), and in which the liquid was conveyed from a receiving tank,—where about half its solid matter was separated,—through five hundred feet of jointed pipe, discharging it finally into a mass of broken stone buried in the natural gravel. . . . As it was believed that this arrangement would eventually become clogged up by the accumulation of slime, sediment, etc., it was decided to retain the old outlet in case of very severe winter weather, and construct new beds for general use." This retention of the old system for use in case of emergency, while constructing new works for regular use, seems to be a wise provision in cases of this sort, answering the same purpose as the duplicate filter beds of larger and more costly installations. The additional filter beds cost only about $1,500, which will be recognized as a low figure for works of the capacity named, the pipe line and reservoir now used being sufficient for additional filter beds that will bring the capacity up to 40,000 gallons daily. This provision in the capacity of pipes and reservoir for increase of filter-bed seems also a judicious

proceeding in situations like this, where the increase in population is sure to be considerable, but impossible to estimate with any approach to accuracy. In these works the grading and construction of the filter beds cost $550, while the pipe line and reservoir cost $950. "The sewage now enters the receiving tank, passing from one chamber to the other through openings in the partition wall, deposits the coarser part of the solid material suspended in it, and, instead of flowing off as before, through a trench-pipe, it rises through a standpipe, and is discharged midway between the top and the bottom into an adjacent reservoir, which, when full, discharges through a syphon, thus intermittently flooding the filter beds, from which sub-drains convey the clear effluent to a small running stream. The reservoir has brick walls and a concrete bottom, and it is covered by a flat roof of 3-inch flag-stones laid on double rows of 3-inch rolled steel beams that are carried by steel cross-girders. When the sewage rises in the tank to the tops of the syphon (about once in 24 hours), the flow through its long leg (that is sealed by the back-water retained by the little dam in the bottom of the outlet chamber) exhausts the air and puts the syphon in action. This empties the reservoir in about 45 minutes. The carrier-pipe terminates in a distributing man-hole, where the sewage may be diverted into either of the two filter beds at will. The filter beds were made by simply removing the top soil and excavating and filling in the natural gravel bank only enough to make a level top service, and by building puddled side embankments."

Ratio of Grate Area, Heating Area, and Cylinder Volume.

UNDER the above title *The Railroad Gazette* (July 9) prints an extract from the report of the American Railway Master Mechanics' Association appointed to investigate and determine the ratio of heating surface and grate area to cylinder volume for passenger and freight engines, whether burning anthracite or bituminous coal, and also the ratio which should exist between the size of cylinder and the length of steam port. The report is extremely able, reflecting great credit upon the gentlemen who composed the committee. Forty years ago, a report of this high character from railway master mechanics would not have been obtainable. It marks a great advance, not only in scientific and practical railroading, but in the profession of mechanical engineering. All we can hope to do in reviewing a document of this length, which, with diagrams and formulæ, occupies nearly six closely-printed columns of the newspapers named, is to give an inkling of its importance, not only to locomotive designers and builders, but to constructors and designers of stationary and marine engines; for, though a locomotive differs in many respects from other types of steam engines, the principles underlying the conversion of heat into mechanical energy are the same in all. For instance, this index to the evaporative value of fuels is surely a collection of data worthy of a place in every engineer's notebook:

INDEX TO EVAPORATIVE VALUE OF FUELS.

No.	Location of mine.	Kind of fuel.	Ratio of heating surface to grate area.
1	Pennsylvania	Anthracite, large	45
2	"	" "	20
3	"	" fine	20
4	"	" "	20
5	"	Semi-bituminous	70
6	"	" "	84
7	Virginia	" "	66
8	"	" "	57
9	"	" "	49
10	Illinois	Bituminous	50
11	"	"	55
12	"	"	71

It is certainly safe to say that the ratios of heating surface to grate area for the best results in the generation of steam vary through a much wider range than is generally known to designers and constructors of boilers and portable engines. Heating engineers have often been at a loss to explain why such differences in results attend the use of the same boiler with different fuels. Of course, they have recognized the fact that these results had a close relation to the fuel, but, without the authoritative statement given in the tables, few of them would be prepared to believe that in a locomotive semi-bituminous coal of some grades requires four times as much grate area in

proportion to heating surface as some grades of anthracite. It does not follow that as great differences in ratios of grate area to heating surface would obtain in boiler furnaces, where natural draft is relied upon, as in most heating installations; but the figures in the table point to much wider differences than are recognized in practice. Here follows another useful set of data.

RATIO OF MAXIMUM ROTATIVE FORCE TO AVERAGE ROTATIVE FORCE AT VARIOUS CUT-OFFS.

Cut-Off Pressure	⅛	¼	⅜	½	⅝	¾	⅞	1
100	1.52	1.31	1.17	1.09	1.10	1.17	1.19	1.20
200	1.47	1.30	1.11	1.09	1.12	1.16	1.19	1.20
Approx. Average	1 50	1.30	1.15	1.10	1.10	1.15	1.18	1.20

This table is made up for locomotives in which the connecting-rod is 9¼ times the crank radius, or about 5 times the stroke; but it is stated that results with other lengths of connecting-rods show but little variation from those presented in the table. The point of maximum rotative force is found to be 15 degrees each side of the 45-degree point. The following conclusions were reached. The ratio of grate area in square feet to total cylinder volume in cubic feet, for simple passenger or freight locomotives, should not be less than 4 for large anthracite, 9 for small anthracite, and 3 for bituminous coal. The ratio of heating surface in square feet to total cylinder volume in cubic feet, for simple passenger and freight locomotives, should not be less than 180 for large anthracite, 200 for small anthracite, and 200 for bituminous coal. Formulæ for working out the proportion for compound locomotives are presented. The ratio of heating surface to grate area should not be less than 40 for large anthracite, 20 for small anthracite, and 60 for bituminous coal.

The proportions given for bituminous coal are also applicable to coke and fuel oil.

The ratio of the fire-box heating surface to total heating surface should be about 10 per cent.

The ratio of tube length to outside diameter should not be less than 70, and may be 90.

A Notable Institution.

THE Webb Academy and Home for Shipbuilders at Fordham, now included in New York city limits, is one of three existing institutions of its kind. Its founder, Mr. William H. Webb, once a prominent and successful ship-builder, amassed a handsome fortune, and still lives, in good health and unusual vigor, at eighty years of age, to enjoy the results of his labors. His life has been marked by industry, integrity, ability, and force of character, and in his old age he conceived and carried out the idea of the institution, which, under the title "A Ship-builder's Dual Monument," is described and illustrated in *Harper's Weekly* (July 10). The description of the institution is extended to include a brief biography of its worthy founder. We shall note here only a few of the facts relating to the institution, which, founded in 1890, occupies thirteen acres of elevated ground, and which, designed chiefly by Mr. Webb himself, has an imposing appearance when seen from a little distance. Doubtless professional architects might find something to criticise in this amateur design; but its general adaptation to the purposes of the institution cannot be questioned. These purposes are the establishment of a home in which "free and gratuitous aid, relief, and support to the aged, decrepit, invalid, indigent, or unfortunate men who, within the precincts of the United States, have been engaged in the craft of ship-carpentry, building of marine engines, or any part or section of the hulls of vessels or engines thereof, together with their lawful wives, will be furnished. Furthermore, to furnish any worthy young man, a native or citizen of the United States, who, after careful examination by the trustees, shall have proved himself competent and of good character, with a free and gratuitous education in the art and science of marine architecture and engineering, both theoretical and practical, and also teach him the craft of ship-carpentry, marine-engine building, and the allied trades, with free board and lodging, tools, engineering implements and materials while acquiring that education." The way in which these

purposes have been carried out honors equally the head and the heart of the founder. The building cost $600,000, and is endowed with $2,000,000, all the gift of this generous man. Its interior furnishing and outfit are of excellent quality throughout, and passenger and freight elevators afford easy access to all parts of the building. "On the third floor are the apartments of the guests and students, by which names Mr. Webb, with considerate delicacy, insists that the old and young who enjoy his bounty shall be known. The guests' apartments are double, for the accommodation of husband and wife, and are fitted up in a way that must seem luxurious to their occupants, who doubtless knew little genuine comfort in their active lives. Each room is furnished with a bureau, wardrobe, wash-stand, and drawers —all of highly-polished maple; the large double bed is of iron, painted white and gold; a carpet of pretty design covers the floor; and even the little ornamental scrap-basket has not been forgotten. The rooms of the students are furnished in similar manner, and all have an abundance of air and light. In one of the large and cheery round towers are the hospital, the convalescents' room, and the nurses' bed-rooms. Here are sick-beds, invalid-chairs, and all sorts of improved appliances for the ailing, while rooms have been provided for the friends of sick guests and students who may desire to have their friends with them when ill. Spacious bath-rooms fitted up with all conveniences are scattered about the dormitories, the building is heated by steam and lighted by electricity, and electric bells and speaking-tubes connect every room with the office of the superintendent." A staff of well-trained servants is maintained. The old people who have become the guests of the Home seem to be as happy as their benefactor intended them to be, and the educational department—the Academy—is filled with eager, earnest students, availing themselves of their splendid opportunity. A carpenter shop, a mold-room and drafting-room, and other facilities for learning the art of ship-building under able instructors, are provided. "All branches of ship-building are taught in the Academy, and the course covers from three to four years. Thus in a few years the government will have at its command in the alumni of the Webb Academy a numerous group of trained marine architects, who will prove a tower of strength in some unforeseen hour of need—a possibility which prompted Mr. Webb to lay the foundations of the academy with exceeding care upon the broadest lines." The good effects of this noble benefaction will become more pronounced as years and experience add to its working efficiency.

By-Products in Gas Manufacture.

THE mutual relations of the by-products of gas manufacture, not from a scientific standpoint, but from the economical and commercial point of view, were discussed at the recent Berlin meeting of the Society of German Gas and Water Engineers, by Dr. H. Bunte, of Karlsruhe. An abstract of a translation of this paper is printed in *American Manufacturer* (July 9). The use of gas-coke for domestic fuel is shown in this discussion to be increasing in Germany, and the association before which this paper was read has instituted a prize contest for the production of the best gas-coke stove. It has been found that by proper crushing, thus supplying coke of specific sizes, as is done with coals, the use of coke for domestic purposes has been much increased. The extension of the use of this fuel in the industrial arts was also urged, it being especially desirable in operations where soot and smoke are objectionable, as in large towns. Gas-coke is an essentially smokeless fuel, and its more extended use in cities ought to be encouraged in every way possible. Systematic endeavor to promote the greater popularity of the fuel, and to demonstrate to manufacturers its advantages, is urged upon the gas companies. But a substitution of coke for coal, as fuel for steam generation, requires alterations of grates and furnaces, and, unless as permanent and regular a supply of this fuel can be relied upon as is that of coal, it would be folly for a steam-user to change from one to the other. Pound for pound, coke is

also a less efficient fuel, containing fewer units of heat than the coal before its distillation in the retorts. Variations in the heating quality of cokes are small (at most, about five per cent.), and result principally from the greater or less quantity of ash contained in the fuel. As to cyanogen, which was once a valuable and profitable by-product, the large output of potassium cyanid which has been placed on the market has lowered the price to an unremunerative point. The demand for ammonia, in the form of sulphate, for agricultural uses seems practically unlimited, but the future of this article of commerce may yet be disastrously affected by the use of "*nitragine*," so called, which enables plants to draw their needed nitrogen from the atmosphere. This new departure in agriculture is looked upon with some anxiety by the manufacturers of ammonia (chiefly gas-works), though, so far, it has not seriously affected the trade in ammonia. The price, however, has suffered from the very large quantities of ammonium sulphate manufactured during the past five years. A considerable quantity of liquid anhydrous ammonia is now used in ammonia ice-machines, but this is not enough to much affect the general market-price of ammonium sulphate, or of such other ammonium salts as the gas-works find it inconvenient to make.

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Magnetic Surveys.

THE great scientific and engineering value of magnetic observations in supplying needed data for engineering developments is emphasized in a short paper read by Mr. William S. Aldrich, C. E., before the annual meeting of the Association of Engineers of Virginia, and printed in *The Journal of the Association of Engineering Societies* for May. The influence and action of the engineering societies of the principal States and cities in encouraging and promoting such service by legislation are strongly urged and solicited. The magnetic elements to be determined by a magnetic survey are: (*a*) "the magnetic declination, or, as commonly called in surveying and marine work, the variation, of the compass,—measuring the horizontal angle between the true geographical and the magnetic meridians at any point;" (*b*) "the magnetic inclination or dip of the magnetic needle,—measuring the vertical angle in plane of magnetic meridian which the freely-suspended needle makes with the horizontal plane at that point;" (*c*) "the intensity of the earth's magnetic force at point of observation,—determined either (1) in its total intensity, or (2) by its horizontal component." A sufficient number of these observations, made at selected points, supply the necessary data for plotting on the map lines showing the characteristic features of the magnetic elements at the time of the observation,—to wit, isogonic lines, drawn through all points having the same magnetic declination or variation of the compass, isoclinic lines drawn through all points having the same magnetic inclination or dip of magnetic needle, and isodynamic lines drawn through all points having the same (1) total magnetic intensity or (2) horizontal component of the earth's magnetic force. Mr. Aldrich says that the most extensive and systematic work of this character has been inaugurated by Maryland. "Many of the early stations of the United States coast and geodetic survey have been reoccupied, and magnetic survey stations have been established at every county town throughout the State, making forty-three in all. There there is one station for about every two hundred and fifty square miles." The magnetic observations made in this State during the summer and autumn of 1896 resulted in the obtaining of data which, he asserts, will prove to be of immediate value to all surveyors and of "great scientific importance in connection with investigations connected with the location of the great rock masses in the State of Maryland." Without the data supplied by magnetic surveys, it is not possible to retrace old lines.

THE BRITISH PRESS

Artistic Electric Lighting.

In an editorial on the numerous instances of incongruous and inartistic electric fittings in the *Electrical Engineer*, June 18, it is suggested that, when electric lights are to be introduced into previously-designed apartments, the designer of the decoration of such rooms should be consulted, or at least a person equally competent to design the electric-light fittings in accordance with the general design of the room itself. The point is illustrated by a reference to two notable instances, one of inartistic electric-lighting work, and one of the opposite type, the effect in the latter being singularly pleasant. Pictorial reproductions are given, which show that, with proper care and attention, a much more harmonious and satisfactory result can be obtained than is usual. The first instance cited,—namely, that of inartistic work,—in a room in the west end of London, "was one in which the artist and designer spent a great deal of time and trouble to produce a perfect specimen of an Empire drawing-room. A year or so later the supply mains came along, with the certain result that the electric light had to be installed. The work was entrusted to a firm of electrical engineers of very high standing in the profession, but who, doubtless, were more used to the foundry and erecting-shop than to the artistic adornment of a drawing-room. As a consequence, their client was allowed to select what took his fancy, and the result was the spoiling of the room, from an artistic point of view, by the supplying of fittings of the 'Benson' style,—fittings which in a modern 'Liberty' style of room would have looked perfectly in keeping, but which, under the circumstances, were most inartistic." A worse effect results in cases where the fittings have no sign of artistic treatment at all, which is the more common case. The making of electric fittings has got into the hands of the manufacturers of gas fittings. "Their idea of electric fittings is simply to turn their old patterns upside down, overlooking the fact that with gas fittings there is not much scope for artistic treatment, whereas with electric light its chief beauty is the easy manner in which it can be treated artistically." It is conceded, however, that the artistically designed and executed fittings are much more frequent now than they were a few years ago. The designing of such fittings is now sometimes done by the designers of the decorations of the room, in cases where elaborately-decorated rooms, in accordance with some special idea or scheme, are constructed. This method is the only one by which to avoid incongruities such as are above set forth.

Facts Relating to Fire-Damp.

Mr. Frederick Delafond, chief engineer of the Belgian mines, has summarized for the inspector-general of mines and president of the French fire-damp commission the principal facts relating to fire-damp outbursts, as observed and recorded by engineers who have studied the subject in France and other countries. A translation of this summary, published originally in *Annales des Mines*, is contained in the *Colliery Guardian* (July 9). According to this summary, outbursts of fire-damp in Belgian mines have been confined to a small number of collieries, generally situated on the southern boundary of the coal fields. Of these collieries only a few disengage fire-damp. The top of the seam appears to exert no influence. Gas is disengaged from horizontally- and highly-inclined fissures of the same seam alike. Disturbances which have effected the seams exert a preponderating influence; only twelve occurred where the seams were regular. A sudden outburst is not generally indicated by any previous circumstance. Sometimes even the working place itself did not appear to give out any fire-damp before the outburst. A large number of instances of outbursts are cited to prove the absence of premonitory indications. Outbursts may occur successively in one and the same seam, at points near each other. This is proved

by a list of explosions, in which these successive outbursts took place. It appears that the taking out of the pillars from a mine operates to facilitate the disengagements. Out of one hundred and thirty-one outbursts, one hundred occurred when the pillars were being removed. A period of exploration and preparation is, therefore, more dangerous than that of actual coal-getting. The disengagements are rare at depths not exceeding three hundred meters, becoming more frequent and intense as the depth is increased. Means for preventing sudden outbursts are discussed, and the boreholes, which have been criticised as not giving sufficient warning, and as reducing the resistance of the working face, are commended. While the force of the criticism is admitted, it is held that, nevertheless, this means of preventing accidents should not be neglected. It is stated that M. Petit, chief engineer of the Saint Etienne collieries, expects to obtain, from methodical boring of advanced holes, valuable indications affecting the security of the mine. A method of prevention advocated by M. Robert-Lintermans is diminished rapidity in advance in stalls and headings. While this precaution is commended, it is not always possible to apply it, and to restrict the rapidity of advance sufficiently to make it effective as a preventive measure. A third preventive measure consists in pushing forward the workings of a less fiery seam beyond those in the others. This method is commended whenever it is practicable, which is not always the case. M. Marsaut has used large mine shots, fired after the men have reached a place of safety. The effect of this explosion is to open compact measures and render them more or less permeable to fire-damp. This diminishes the pressure of the explosive gas, lessens the danger, and gives rise to blowers that reveal critical states. Measures for preserving the men from the consequence of sudden outbursts are the use of safety lamps and vertical air partitions, means for insuring the rapid evacuation of fire-damps, and the service of compressed air, in which air is discharged at about every thirty meters to within one hundred or two hundred meters from the working face. In the event of the workings becoming infested with gas, this distribution of air will allow the men to escape asphyxiation.

The Oxidation of Iron and Steel Structures.

IN an article by Mr. William Mackenzie, assistant engineer of the Intercolonial Railway, he describes, in *The Canadian Engineer* for July, under the title "Painting Metal Bridges," a series of tests or experiments (begun in 1895) upon the value of various paints as a protection to iron. He withholds the names of manufacturers, but gives his method of testing paints, and presents a general statement of facts which will interest civil engineers, architects, and builders. We herewith present a brief abstract of Mr. Mackenzie's article. Twenty-four new wrought-iron plates, each one foot square, were painted with two coats of different paints. Three of these were painted with ready-mixed paints; the rest were covered with paints of different kinds, each mixed with the same boiled linseed oil. The plates so prepared were exposed to the action of corrosive influences by suspending them to one of the chord eye-bars of a steel railroad bridge 1,900 feet long, which crosses a strait, or an arm of the sea, about thirty-five miles from the Atlantic ocean. Here the plates were exposed to the action of salt spray in rough weather and of salt air at all times. The situation appears to be a peculiarly trying one. Even a light north-east breeze causes spray to be dashed against the floor, and in storms spray is thrown up on the floor and across the bridge. Unprotected metal, of course, corrodes rapidly under such conditions. The bridge itself, built in 1890, requires very careful and constant attention, that defects in the painted surface may be remedied as they appear. This bridge was given a coat of iron-oxid paint in the shop, and another coat when erected. In 1892 it was found to be considerably rusted. Two more coats of the same kind of paint were then put upon the lower chords and floor system, but with-

out proper inspection or scraping. "In 1894 scales one-eighth of an inch thick were removed from the end stiffeners of the floor beams on the north side. Pieces of this scale were trimmed to exact dimensions and the cubic contents calculated." This scale was found to weigh more than one-half as much as new steel. In 1895 the bridge was again painted with two coats of iron-oxid paint, this time after thorough scraping, and it is now reported to be in good condition. Thus much for the influences to which the twenty-four plates were exposed when hung on the chord eye-bars above named. The results are presented in a tabulated statement, which names the kinds of paints used, and states how each pigment was applied and the time during which each plate was exposed. Other data, such as the date of the painting, the number of coats applied, and the date of exposure, are given. Finally the condition of each of the plates is described. Engineers will be much interested in these data, as presented by Mr. Mackenzie; suffice it to say here that, after exposures ranging from eight to twenty months for different plates, only five were found to be in good condition. Four more were in fairly good condition, and thirteen were in bad condition, "rusted all over," "very much rusted," "covered with rust; paint all gone," being samples of the terms used to described their different states. The article also presents a collection of data derived from various high authorities and bearing directly upon the effects upon iron and steel to be expected when these metals are exposed, without proper protection, to the action of salt air or the spray of sea water. Mr. Mackenzie regards the pigmentary matters mixed with the oil as of comparatively small importance. "The oil," he declares, "is king; any finely-ground pigment, inert toward the metal and oil, will last till the oil decays and wastes away, and against this waste and decay there is no remedy." The directions for applying paint to iron and the preparation of the metal for receiving the paint are comprehensive and specific. This is one of the best essays on the subject that has recently appeared.

A Remarkable Exhibition.

THE London Architectural Association celebrates its semi-centenary this year. As part of this celebration there has been placed on exhibition at the rooms of the institute a collection of architectural drawings and designs. Mr. R. Shekelton Balfour makes this exhibition the subject of a very readable article in the *Journal of the Royal Institute of British Architects* for July. The object of the exhibition appears to have been to present a chronologically-arranged collection of drawings and designs which might adequately convey an impression of the fifty years of evolution that have brought us to the "present-day draughtmanship, and the individual influences responsible for this evolution." This collection will also enable the observer "to follow in more subtle fashion all the strange phases of alternating admiration and unpopularity which have been formulated in the inconstancy of architectural fashions during the last fifty years." The chief characteristic of the exhibition is its wide recognition of "the intrinsic merit of different styles." Among the differences between the drawings of thirty years ago and those of the present time the increased employment of measured drawings is noted. "Formerly the measured drawing was not so largely in vogue as it is now, and the details of mouldings and enrichments were sketched to a small scale, with perhaps a few added dimensions at the side. Now our tendency is rather to reverse this process, and we draw our work out to scale on the spot, and persevere in making full-size drawings of all intricate and important portions." The result is visible in the decrease of perspective drawing in sketching-tours. The scale-drawing reveals defective proportion which a well-executed perspective pictorial representation might mask. "It was fifty-two years ago when one of the earliest drawings in the exhibition was made. This is an elaborately-inked-in water-color drawing of a church porch by Mr. J. K. Colling, which serves to illustrate the remarkable, though somewhat labored, effort which was so frequently relied on in those days

for effect." Three drawings in sepia and cobalt, executed in 1852, are also noted as being really pictures. The contrast between these and some adjacent ones, recently produced by the late W. Burges, A. R. A., is great. These "are distinguished by a boldness and originality which even our most advanced draughtsmen might hesitate to commit themselves to nowadays." and which "are pregnant with the character of their author." Of present-day architectural note-books, Mr. Balfour says that "they are a medley of jottings of all sorts and all dates of work;" much greater thoroughness is the characteristic of the sketches of the present date. "Thirty or forty years ago it was the *effect* produced by detail which was aimed at in the sketch-book. Now we go more to the root of the matter . . . and try to discover how the effect was produced." In perspective sketching—no longer the approved method—a good draughtsman may, and often does, unintentionally add a charm to his work which may conceal faulty proportions; and Mr. Balfour maintains that no mere sketch is a sufficient guide for the reproduction, in modern designs, of desirable effects transferred from old work. "The students' drawings of the last few years also tend to embody a paradoxical combination of slightness and elaboration; an amplitude of full-size details, coupled with an explanatory key-drawing of the whole for their elucidation. But in this we have the gist of the whole subject, a method surely preferable to the older one of filling in and completing the drawing with more or less accuracy, according to whatever the scale may be in which we are working." The closing decade of the period covered by the collection is most fully represented, showing great diversity of style and subject. The cosmopolitan taste of the present time is conspicuous in these exhibits.

The Improved Condition of Labor in England.

THE progress made in England during the reign of its present honored queen has been made the subject of a great deal of self-congratulation in the "British press." No one can find fault with this, for really this feeling has a solid foundation. The *Journal of Gas Lighting* (June 29) has an article entitled "Labor in the Victorian Age," in which it sets forth the enormous improvement in the status of labor in the last sixty years. The London *Times* is quoted as asserting that "no class in the community has more reason to be satisfied with the results of the last sixty years than the workingmen. It was the utmost demand of their best friends at the beginning of the present reign that they should be free to work out, by combination or otherwise, in their own way, their own salvation; that their societies should be legalized; and that the criminal law should not be used to increase the power of capital,—in a word, that they should suffer from no disabilities. They find themselves in 1897 in the position of a favored class, fenced about with special legislation, and possessed of some rights denied to others, and this period has also been for them one of unexampled prosperity. Their wages have risen, while the prices of food and most articles of consumption have fallen. The State educates their children *gratis*. The State makes the acquisition of allotment easy for them. The municipalities give them recreation grounds and free libraries; if they save, the State finds them an investment without risk, and pays them interest at a rate which they would not always obtain elsewhere. One of the latest acts of the house of commons was to approve a measure which, surpassing the dreams of labor leaders of sixty years ago, binds the employer to compensate an injured workman, even if the former is blameless. . . These ameliorations were not in the main extorted by labor leaders from a reluctant oligarchy, nor were they the work of 'popular,' to say nothing of paid, politicians. The factory acts, which have placed a large collection of the British operative population in a position envied by the same class in other countries, were freely granted from above, with no idea of propitiating a class of voters." There is a good deal more of the same sort, but at the end it is admitted that there

is another side to the picture. The decay of the old apprenticeship system, and the cessation of the friendly and direct personal intercourse once common between the employer and employed, are lamented. There is also in the cities a growth of the shiftless, thriftless class not amenable to any rapid improvement. However, these defects are thought to be more than compensated for by the grand advance of the laboring class as a whole.

The New Canadian Mail Service.

THE new line of transatlantic fast mail service, now arranged for, and which the Canadian government has long been anxious to obtain is submitted to some rather caustic criticism in *The Engineer* (London, July 2). Now that these arrangements are concluded, our contemporary doubts that the Canadian government is any nearer to the attainment of its desire, declared to have been the getting of a transatlantic mail service without paying for it; and, although the sum of £154,000 a year, to which it has obligated itself in the establishment of this service, is not exactly a trifle, the English critic says, not very urbanely, that, "if current rumors are to be trusted, the same cheeseparing niggardliness which has hitherto stood in the way of a Canadian mail service being organized is now likely to dwarf its efficiency and popularity when called into existence." The contract for this service has been awarded to an obscure firm in Newcastle-on-Tyne, hitherto owners of a line of cargo steamers. Of this firm *The Engineer* says: "As regards the gentlemen who have secured the contract for performing such a difficult service as that of running a line of fast mail steamers between these islands and Canadian ports during not only the summer, but in the winter season also, all we know is that they reside at Newcastle-on-Tyne, where they own or manage a fleet of some half-dozen or so of cargo steamers, which are called 'turret ships,' presumably because there is nothing at all like a turret about them. This is the sum of our knowledge of Messrs. Peterson & Tate, who, no doubt, are perfectly sincere in their belief that they know how to run a line of fast mail steamers; know what kind of ships are required for the service; know how much it will cost to build and run them, and what subsidy will recompense themselves and their shareholders for the capital put in the concern. But it is not sufficient for these gentlemen to have confidence in themselves; for the public who would like to avail themselves of the new service will demand some guarantees that, when they leave Great Britain in the company's steamers, they will be conveyed safely and comfortably to the other side." It is added that, if in respect of safety and comfort, speed and regularity, the new steamers do not equal the great steamers now plying between New York and Liverpool, the failure of the service is assured in advance. It is inferred that ships of the so-called turret type will be employed in this service. These ships are built by the Messrs. Doxford, of Sunderland. Our contemporary uses also the term "bottle-neck" as a special name for these ships; and, although it seems difficult to obtain reliable particulars of the ships to be built upon this type, the opinion is hazarded that such vessels—admittedly good as ocean tramps—are, on general principles, ill-adapted for a North Atlantic passenger trade, and that it will be impossible to make comfortable passenger ships of this type. The high freeboards and other features which have given to the great transatlantic ships of the present day such possibilities for comfortable accommodation of passengers would be wanting in what the critic calls the "'bottle-neck' monstrosity." A cheap construction at the expense of comfort and luxury in a line of modern transatlantic steamers would certainly be the direct road to financial failure.

Continuous Rails.

WITH reference to stresses upon continuous beams, to which class the railway rail is referred, *The Engineer* (London, July 9) points out that the condition of uniformity of section is absolutely and completely insured, but that "the rail does

not altogether satisfy another assumption put forward in treatises and text-books as indispensable to the security of the continuous principle, and that is that the points of support should be unmovable. Under the circumstances, it is fortunate that the rail does not vigorously comply with this theoretical proviso, for, if its points of support—that is, the sleepers—were so solidly grounded, it would not be long before hammering and hard running would place the whole permanent way *hors de combat*." A comparison of the rail considered as a girder with the system of bridge-construction invented by Gerber and patented in Germany shows some analogies. "In this system (Gerber's), instead of the girder being unalterably continuous from end to end, it is made continuous over the supports upon one side of it, only for a certain distance, which varies with the lengths of the span, and then hinged or pivoted at this point. Carried to its logical conclusion, this hinging or pivoting of the part over-hanging the points of support gives us the cantilever."

From this point of view *The Engineer* proceeds to build up an argument in favor of reducing the number of joints in a railroad track by using longer rails, or by another process which has lately come into vogue in America,—to wit, cast-welding the ends of rails together. Unquestionably the rail joints are the weakest points in the track. Rails exceeding a certain length cannot be conveniently rolled, transported, and handled. Our contemporary gives sixty feet as the longest rail ever yet laid on railways, but thinks that rails one hundred feet long have been rolled. The adoption of the continuous rail-tracks has been retarded by the fear of the effects of contraction and expansion under variations in temperature. It has, however, been proved that, for lengths of more than one thousand feet, temperature stresses need not be greatly dreaded. The ends of the individual rails in such a length may be joined either by electric welding, or by cast-welding, as it is called, which, while we believe it does not make so good a joint, is at present cheaper in first cost than electric welding. Our contemporary, however, thinks the joints made by cast-welding are equal to those made by electric welding, and perhaps our estimate of its efficiency is too low. It is certain that it has been satisfactory as a substitute for the ordinary rail-joint. That the temperature stresses really exist cannot, however, be doubted. They may be neglected, if experience proves that their effects are less injurious to a railway track than those of numerous joints.

Septic Tank Treatment, and Coal as a Sewage-Filtering Material.

IT has recently been demonstrated that coal is a very efficient material for filtering sewage. A paper was recently read upon sewage-filtration by Mr. Donald Cameron, engineer of the city of Exeter, in which he presented to the Devon and Exeter Architectural Societies a description of the details of a septic tank installation at Exeter. Mr. Cameron seems to consider himself (probably with justice) as the inventor of the septic tank system, which has for its object to favor the multiplication of micro-organisms and to bring the whole of the sewage in the tank under their influence. These tanks are made of ample size, covered to exclude light and, as far as possible, air. The incoming sewage is delivered below the water-level; the outgoing sewage is also taken below the water-level, the purposes being to trap out air and to avoid disturbing the contents of the tank. The decomposition of the matters which would otherwise undergo putrefaction is effected by the presence of these micro-organisms, their products being water, ammonia, and carbonic acid, with some other gases. No sludge is found. The bottom of the tank, after six months' use, when exposed, shows only a thin layer of black earthy matter, together with mud and grit, which settles out of the water. A tenacious scum forms at the top, which consists of the lighter solids in process of decomposition. The effluent is not offensive, and it is claimed that it will not ferment, when the system is properly carried out, as the decomposi-

tion in the tank is complete. Thus purified, it may flow out upon land for fertilization, containing in solution all of the constituents valuable as food for plants. This system has attracted a good deal of attention, particularly in publications devoted to municipal affairs, as well as in architectural publications. *The Builder* (July 3) prints a paper by Dr. G. Reid, medical officer of health for Staffordshire, in which he not only approves of this tank system, but strongly recommends a system of filtering, which he calls the "New Garfield Filter," in which coal is used as the filtering material. He states that Mr. Garfield, manager of the Wolverhampton Sewage Works, accidentally discovered that coal slack was very effective in purifying dirty water. This led him to construct a small filter, with which he experimented upon the Wolverhampton effluent. The result was so favorable that, in company with Mr. Jones, a chemist, he instituted a set of experiments upon a larger scale, with still more encouraging results. He describes the filter, the bed of which is a bed of coal, the first six inches being made of coal nuts, in sizes of about one-half inch cube, blended with a layer of one-quarter-inch cube coal, above which is a nine-inch layer of one-eighth-inch cube coal, upon which is placed another layer of one-sixteenth-cube particles one foot nine inches in thickness. Upon the top of this is placed another layer of coal dust two feet thick, mixed with such coal as will pass through a three-sixteenth mesh. The tank effluent is discharged continuously upon this filter, for a period of twelve hours. Twelve hours are allowed for aeration.

It is claimed that a square yard of this filter will produce a highly-purified effluent, if charged at the rate of two hundred gallons for twenty-four hours. Above this rate the result is not so good. It is also claimed that the filter possesses exceptionally purifying powers, apart from nitrification—the nitrifying properties increasing with time. This new departure will be watched with a great deal of interest. We think it too early to forecast its future.

Educational Requirements for Electrical Engineers.

THE survival of the fittest, a law which holds good in the world of nature, also proves its validity in the struggle for place and profit in the active industries of the world. Considering how recently the profession of electrical engineering has come into existence, the extent to which it has become overcrowded is almost phenomenal. This is all the more remarkable when we consider the amount of technical and practical knowledge, required for the thorough equipment of electrical engineers. The rapidity with which the ranks have been filled in this field may be partly accounted for by the early overflow into it, from other departments of engineering, of men who had been unsuccessful, or only very moderately successful, in their practice. The technical schools now turn out each year numbers of new recruits more or less qualified to compete with those already engaged in the same kind of work. Of course, this accession to an already-filled branch of engineering practice absorbs some of the business which those now in it could do, and which they would like to get. This produces a set of conditions highly favorable to the operation of the law of the survival of the fittest, and the elimination of those whose equipment, ability, or character in other respects is defective. These either fall out of the ranks altogether, occupy inferior and unremunerative positions, or become, as *The Electrical Review* puts it, in an article on "The Training of an Electrical Engineer" (July 9) "men in a groove, along which they travel to the end, with their pluck taken out of them by repeated and vain efforts to pick up, now, what they failed to learn when young—or, disgusted with the retrospect, they turn to another career." This failure to gain the proper equipment before commencing practice is not always the fault of the individual who suffers from it. It is sometimes due to a defective course, which produces in the mind of a pupil only imperfectly instructed in theory the idea that he has been practically trained, and leads him to undertake that which he is incapable of executing.

It may be the failure of his instructors to perform their obvious duty toward him when, at the end of his first term or first year, he has shown his natural unfitness for the profession of engineering. Our English contemporary strikes at the very root of an evil which has gradually crept into modern systems of technical education when it says: "The fundamental idea that a man who has spent all his life in teaching, thinking, and reasoning is the proper person to entirely educate youths for any special practical profession is mischievous." Of course this idea is mischievous; the modern technical schools have recognized this in their provision for a more or less practical training in work-shop and field, under the direction of practical instructors. The principal weakness in this system is that, while such training in the schools is good, it cannot be carried far enough during a course of theoretical study, and that, though its insufficiency is precisely what should be impressed upon the minds of students, it has been the effort, in the catalogues of some of these institutions, to create an impression upon the public mind that it is thorough. Thus we read in such catalogues about the excellent forgings turned out by students in the forge shop, or the nice tools made by students in the machine shop, etc. The fact remains that even the brightest, quickest, and most assiduous of these young graduates, confronted with the really practical work of a regular machine-shop, or of the office of a civil engineer or architect in good practice, will, if sensible, soon discover that the practical training he received in the school was thorough only as far as it went, and that it did not and could not go very far. The conceited ass who comes out of his school with a graduate's diploma and the idea that he can now do anything, and can even successfully compete with those who have time and again met the practical difficulties of engineering and conquered them, will come to grief. There is another phase of this question. The over-filled ranks of the engineering professions show that, for merely *average* men, there are left only average positions or, as we perhaps could say with truth, less than average positions. First-rate men, failing to get first-rate positions, are fain to fall back upon merely average positions biding the time —which, indeed, may never come—when a vacancy of a first-class position may open to them. Even when such a vacancy occurs, the competition for it on the part of other first-rate men, occupying average positions, will be fierce, and only one will be chosen to fill it; thus the average position must be the one occupied by the majority of professional men, no matter how good their educational equipment. The possession of such an equipment, however, gives an aspirant a chance, when a door does open, that otherwise he would not get.

The New Denayrouze Burner.

IT may be well to receive the current accounts of this new gas-burner with some reserve, until they are confirmed or disproved by subsequent developments. It is safe so say, however, that, if the statements published in foreign journals—for example, the *Journal of Gas Lighting* (July 6)—approximate closely the actual facts, the gas industry has been put into possession of a rival of the electric light which the latter will find to be a powerful competitor. It is said that by substituting for the hitherto employed electric motor, or the jack-wheel mechanism for creating draft, a device called an "expansion chamber," as good results in illumination are secured as by the mechanical method. By this device, it is said, air and gas in suitable proportions are brought together and mixed, acquiring just as much motive force as when propelled by a fan. The expansion chamber is placed between the mantle and the Bunsen burner. Exactly how it operates to produce the result claimed is not very clearly explained.

THE FRENCH AND GERMAN PRESS

The Electric Furnace.

AMONG the papers presented at the convention of the Electrochemical Society at Munich, and published in the *Zeitschr. für Elektrochemie* for July 5, is an interesting discussion of the widening uses of the electric furnace, particularly in applied technology. A paper was read upon the subject by Herr Pflegler, of Frankfurt, who called attention to the absurd claims made in some quarters as to the capacity of such furnaces, in view of the known theoretical possibilities. In fact, an electric furnace is a tremendous power-eater. A furnace which consumes a current representing 250 to 300 electrical h. p. is an insignificant-looking apparatus compared with that required for the generation of the energy which it so readily absorbs. In the case of the manufacture of calcium carbid, Pictet has shown that theoretically 1 h. p. can produce in 24 hours a little less than 4 kilograms of calcium carbid. Nevertheless a number of builders of electric furnaces and promoters of enterprises have claimed results superior to this maximum theoretical output. Claims are made for some furnaces that they will readily produce 9 to 12 kilograms per horse power in 24 hours, regardless of the absurdity of such statements. The actual conditions as to temperature in such furnaces are practically the same in all constructions, depending entirely upon the current, and the only improvements which may be looked for in construction must be in the direction of preliminary heating of the materials, reduction of losses by radiation, etc., enabling the theoretical maximum to be approached, but certainly never exceeded. Herr Pfleger cites a case in which an electric furnace of English construction was erected in Spain under a guarantee to produce 12 kilograms per horse power in 24 hours, but so ignorantly was it designed that, when the current was started, the whole furnace melted down to a heap of slag! Besides the production of calcium carbid, the electric furnace is finding application for the separation of metals by distillation. Some curious results have been obtained in these directions, since the distillates do not appear to consist of the pure metals, but rather to be real gases, containing hydrogen, and giving in the spectroscope numerous lines which do not belong to the metals vaporized. Another application of the electric furnace is that of the production of phosphorus from alkaline phosphates, for which several patents have been taken out, and which involves temperatures below those required for the production of carbid. Altogether, the future of the electric furnace in the domain of chemical technology seems to be materially extending, and, with enlarged experience, many new applications will doubtless be found.

Street-Washing in Germany.

UNDOUBTEDLY one of the best methods of keeping streets clean is that of frequent flushing with water, especially when the sewer outlets are so planned as to permit all the solid refuse to be washed out through them along with the water. In many cases, however, the supply of city water does not permit the liberal flow necessary for a thorough flushing, so that this luxury can be permitted only when an excess of water is on hand. The city of Oldenburg, near Lubeck, has provided an independent water-supply for the especial purpose of keeping the streets washed, this being one of the numerous sanitary improvements which have resulted from the cholera epidemic of 1892 in the North seaports. The following details of the installation are from the issue of the *Gesundheits Ingenieur* for July 15. In order to avoid the cost of new buildings, the pumping plant is placed in one of the electric stations where space was available, the water being taken direct from the river Hunte, the pumps being driven by belt from turbines. A system of high-service mains, altogether distinct from the regular water-supply, is connected with

this pumping plant, and a pressure of 65 feet head is maintained by an automatic regulator permitting the excess water to be returned to the river whenever the demand is reduced. This high-service pumping system supplies thirty-seven flushing hydrants placed at such points of elevation as to permit the streets to be cleared by the slope. The hydrants are so arranged that their ordinary discharge is through openings in the curb at the gutter line, but they can also be immediately converted into fire plugs for hose attachment, either for street-sprinkling or for fire-engine supply. Since the river water at Oldenburg is unfit for household use, the plant above described is available only for the special purposes for which it was planned, but the expense of thus using a local supply of brackish water for purposes of street-washing and fire-service is so moderate that the method is worthy of consideration in other localities. The entire cost of the Oldenburg plant was less than $7,000,—that is, less than $200 per hydrant,—while the economy in street-cleaning alone would soon repay this, after which the cost of operation would be much less than by any other method, not to mention the superior sanitary advantages.

The Jungfrau Railway.

WE have noted in previous issues the progress of the rack railway now being constructed to carry tourists to the summit of the Jungfrau, but one of the peculiarities of this road is worthy of special notice—*i. e.*, the motive power. This is described and discussed in an article by Herr E. Strub, in the issue of the *Schweizerische Bauzeitung* for July 17, with a profile of the railway and sectional views of the engine. The motive power is to be electricity, an overhead-trolley system having been adopted. The current is to be generated from the water power produced by the ice melting and flowing down into the valleys in ample volume and head for all the requirements of the plant. This source of power most accommodatingly adapts itself to this service. In summer, when Switzerland is full of tourists, the rapid melting of the ice and snow keeps the streams unfailingly full; in spring and fall a fair supply is available; while in winter, when power might posssibly be lacking, there is no demand, all of which is most convenient. The maximum power required for a load of 80 passengers on the maximum grade of 25 per cent. is 211 h. p., and, an allowance of 50 per cent. efficiency being ample, the plant has been arranged for a turbine power of 500 h. p. for each train. The generating plant is to be installed at once, so that it may be used for the work upon the road, operating the construction cars, rock-drills, lighting, etc., and be in working readiness as soon as the roadway is completed.

The drawings given of the electric locomotive show that every precaution has been taken to assure power, safety, and control. The mechanism is doubled throughout, there being two motors, each with its own gear train to its own pinion engaging with the rack between the rails, with ample power for independent propulsion, while a triple system of brakes provides for the safety of the passengers in an emergency.

As several engines and cars may be on the road at the same time, the power plant is made of sufficient capacity to supply 2,000 h. p., but at first only two 500-h. p. turbines will be installed, the others being left until the demands of travel shall require them. The water will be brought in a wrought-iron pipe nearly a mile long and 5 ft. 11 inches in diameter, the effective fall being 116 feet, and the volume averaging 212 cubic feet per second. The power plant will be situated at Lauterbrunnen, where it will doubtless be an attraction to engineering visitors as well as to tourists making the ascent.

Improvements in the Cinematograph.

THE modern devices for the projection of moving images upon a screen before an audience, known under a multiplicity of names, such as the cinematograph, biograph, kinetoscope, etc., maintain their popularity, in spite of numerous defects and objections. Of these the most serious are those of danger of fire, due to the

proximity of a film of celluloid to the intense heat of the electric arc, or the oxy-hydrogen lamp, and the annoyance and fatigue caused by the unsteadiness of the images and the flickering of the illumination. The disastrous fire at the *Bazar de la Charité* in Paris has led to the invention of various safety-devices against fire, but a simple and effective precaution against such accidents is readily found in a water screen between the light and the film. The Amschutz Cinematograph, described in *La Revue Technique* for June 25, is intended to overcome the flickering of the present forms of apparatus, and its success abroad seems to warrant the claims made for it. As is well known, the operation of the cinematograph depends upon the rapid projection of successive images, and in all the present forms the light is obscured while the film is in motion. Between the light and the film is a device which is the counterpart of the photographic shutter with which the original images were made, and thus successive flashes of light are made corresponding with the successive series of pictures. It is this intermittent flashing of the light which produces the well-known flickering. The Amschutz device seeks to obviate this by using two lights and two sets of pictures. Everyone is familiar with the dissolving-view apparatus, by which one picture is made to melt away into the next. In the Amschutz cinematograph there are two lights, two films, and two projecting lanterns. The lanterns are inclined so that their pictures are projected on the same spot. The pictures are arranged alternately on the two films, all the odd numbers being on the first and the even ones on the second. The shutters are so arranged that one light is exposed as the other is obscured, and the illumination is practically continuous. The effect is said to be a vast improvement on the intermittent system, the annoying flicker being entirely absent, and a steadiness and smoothness attained which adds greatly to the comfort and satisfaction of the spectators. Doubtless further improvements will continue to be made until a high degree of perfection has been, reached.

Frictional Resistance of Riveting.

ALTHOUGH the strength of a riveted joint lies mainly in the shearing strength of the rivets and plates, yet it is usually recognized that the frictional resistance of the parts adds more or less to the strength, according to the manner in which the joint is made. The exact amount and nature of this resistance are generally more a matter of conjecture than of precise knowledge, and any contribution to our stock of information in this direction must be welcomed. A number of experiments have recently been made in Holland by M. J. Schroeder van der Kolk, and published in the Transactions of the Royal Institute, and these valuable results are now given to the public in the issue of the *Zeitscher. d. Ver. deutscher Ingenieure* for June 26, with illustrations and many diagrams. The experiments included a great variety of conditions, covering both hand and machine riveting, with holes of various sizes and with various arrangements of rivets, the object being especially to discover the true strength of riveted work in bridge-construction and similar work. Space will not permit a full account of the work and the entire record of results, but the general summing-up contains many points of interest. The frictional resistance was shown to be a much greater factor in the strength of a girder than is usually admitted, but this source of strength is greatly diminished if for any reason the plates begin to slip, since the working of the plates with every vibration soon loosens the contact sufficiently to cause the friction to become insignificant. One source of this reduction of friction is the unequal elasticity of the various members. Thus in a butt joint the cover strips should have the same elasticity as the plates themselves, or else, under deflections quite within the elastic limit, the parts will begin to work upon each other to an extent which will soon diminish the friction; hence this fact should be taken into account in proportioning the members of a joint. A similar action also occurs in built-up girders and like constructions, and in all such cases the question of relative elasticity should be con-

sidered. The diagrams show that the frictional resistance is a very important factor in the strength of riveted work, the yield of the joint increasing very rapidly after slippage begins to take place.

The elasticity of the rivets is important in this action, as well as that of the plates, and when, as in hand-riveting, the rivets do not entirely fill the holes, better results are obtained by having the holes slightly larger than the rivet diameter; with machine-riveting, however, it was found desirable to have the holes well finished close to size. The entire subject is very thoroughly treated and fully illustrated in the articles referred to, and it is to be hoped that similar tests will be made in other countries to confirm or modify the results, as the case may be, by adding to the meager stock of data at present available.

Coal Calorimeters.

THE determination of the calorific value of a given fuel is becoming of more and more importance, in view of the tendency at the present time to refer all tests of heat motors to the actual calorific capacity of the fuel used. Various methods are in use for this purpose, the deduction from the chemical analysis being the principal one; but, whenever possible, it is desirable to check this by an actual test of the fuel by measuring the number of heat units evolved during combustion in a special apparatus. A full discussion of the subject by Herr L. C. Wolff, based upon experimental investigations made in the laboratory of the Magdeburg Steam Users' Society and published in the *Zeitschr. d. Ver. deutscher Ingenieure*, contains some points worthy of special attention. Referring first to the chemical method, Herr Wolff notes that the formula of Dulong:

$$8100\ C + 28800\left(H - \frac{O}{8}\right) + 2230\ S,$$

should be somewhat modified, if all the conditions are to be provided for. A portion of the sulphur is burned to $S O_3$, and the coefficient of this should be 3,300, instead of 2,230. The hygroscopic water contained in the coal is vaporized, and passes up the chimney, and for this an allowance of 600 units may be made as an average value. The principal constants are subject to slight modifications because of later determinations, and these, when incorporated, give what is known as the "Verbands-Formell," from the fact that it has been adopted by the German Society of Engineers and by the International Society for Boiler Inspection. The formula reads:

$$\text{Calories per Kilo} = 8000\ C + 29000\left(H - \frac{O}{8}\right) + 2500\ S - 600\ W,$$

all values being in the metric system, and W indicating the hygroscopic moisture in the coal. The use of any formula, however, involves a chemical analysis, while with a suitable calorimeter the calorific value may be determined directly with little if any more labor or expense than is involved in analyzing the fuel. The principal calorimeters used are the Berthelot and its modifications, or the Mahler bomb, which in Germany has been especially used with success by Prof. Stohmann. The principal objection to these instruments has been their high first cost, but Herr Wolff describes a simplified form of bomb designed by Dr. Kröker, which is reasonable in price, costing only $107 and possessing some advantages, particularly an attachment for measuring the quantity of steam evolved, by absorbing it in calcium chlorid. Herr Wolff's paper gives some interesting examples of the application both of the Kröker and the Mahler-Stohmann calorimeters, with the computations fully worked out. Altogether it must be considered a valuable contribution to practical thermodynamics.

A French Aeroplane.

THE success which has attended the experiments of Professor Langley towards the solution of the problem of mechanical flight gives added interest to an account of the experiences of MM. Tatin and Richet, contributed by M. Marey to *Comptes Rendus* for July 5, in the form of a note to the French Academy.

These experimenters formally announce that a steam aeroplane weighing 73 pounds

sustained itself in the free air, and traversed a distance of 460 feet in a straight line at a velocity of 59 feet per second, propelled by its self-contained motive power. The machine consisted of a body containing the motor, sustained by two fixed wings of about 86 square feet of surface, and with a spread of 21.7 feet, together with a fixed tail to steady the flight. The car was made of light pine wood, and the whole apparatus thoroughly braced together with a system of steel wires. The area and inclination of the supporting surfaces were computed according to the formulas of Duchemin, modified by the necessity of considering the obstruction due to the wire trussing and framework. The actual power was estimated as double that theoretically required by the angles, weights, and velocities assumed; and in practice it was found that the above velocity of 59 feet per second was necessary to sustain the apparatus. The motor consisted of a small steam engine with boiler and furnace complete, operating two screw propellers, one in front and the other behind, revolving in opposite directions. The total weight of 73 pounds included sufficient fuel and feed-water for a flight of more than three miles. A similar apparatus was tried as long ago as 1890, and flew successfully for a distance of 250 feet, when one of the wires broke and became entangled in a propeller, throwing the machine to the ground and wrecking it.

The present apparatus was constructed in 1896, and, after some mishaps, was put in complete order, and, as above related, made a successful flight in June of this year. The constructors are assured that these experiences have demonstrated to them the correctness of their assumptions, and will persist in the effort to attain still greater success on the same lines.

Submarine Telegraphy.

A NOTE recently presented to the French Academy by M. Leaute, and published in *Comptes Rendus* for June 14, describes a new receiving apparatus for submarine cables devised by M. Ader, which possesses some novel and valuable features. At the present time the transmitting-capacity of a cable is limited by the receiving apparatus, it being difficult to surpass a speed of more than six hundred signals per minute. Both the mirror receiver and the siphon recorder of Lord Kelvin are limited by the fact that a certain time is required for each oscillation, and that, when too rapid transmitting is attempted, the signals become undecipherable, owing to interference of one vibration with the next, due to inertia of the parts with the siphon recorder, and to the fatigue of the eye with the mirror apparatus. The improved recorder of M. Ader is based upon the action of a magnetic field upon an element of current. The magnetic field is furnished by a powerful permanent magnet, between the poles of which passes a fine wire traversed by the current transmitted through the cable, this wire being strained by a small tension spring at one extremity. According to well-known laws, the wire tends to displace itself, either forward or backward, as the direction of the current may determine. Since the wire is supported at both ends, it oscillates; and its oscillations bear a definite relation to the electrical waves by which it is traversed. The wire used is only 0.02 mm. in diameter, and responds very promptly to the variations of the forces by which it is solicited. By using a very minute distance between the contact points of the transmitter—not more than 0.0005 mm.—the magnetic circuit is almost closed, and the apparatus operates under the best conditions. The vibrations are recorded photographically, giving a permanent record, which may be translated subsequently, while the speed of transmission, and consequently the capacity of the cable, are greatly increased. In the first instrument made, a speed of six hundred recorded signals was attained on the transatlantic cable between Brest and St. Pierre, though the previous recorder had not surpassed four hundred signals; while on the cable between Marseilles and Algiers the new apparatus records sixteen hundred signals per minute, as against a maximum of six hundred for any other apparatus which has shown practical results heretofore.

A Railway Speed Indicator.

IN the course of some experience recently made on the Berlin locality and published in *Glaser's Annalen* for July 15, it became necessary to procure a record of the speed of trains on various portions of the road. For this purpose a very simple and successful recording speed-indicator was devised by Inspector Leissner, which is worthy of notice here. The apparatus consisted of an ordinary Morse recording instrument, the paper strip being moved by clockwork and the contact being made and broken by a sort of commutator on the car axle. The commutator was arranged so that two contact springs rested upon a sleeve on the shaft in such a manner that current flowed for one half a revolution and was interrupted for the other half, thus making a dash and a space on the ribbon correspond to one revolution of the axle. Since the paper is given a uniform motion, it is evident that, when the train is moving slowly, the dash and space will be longer than when a higher speed is attained, and a glance at the ribbon will show whether the train is moving rapidly or slowly. By marking the length of ribbon corresponding to the one minute of time, and counting the number of dashes contained therein, the number of revolutions is given at once, and from the diameter of the wheels the actual speed can be computed very precisely. In the experiments referred to, the paper ribbon was ruled so that one second of time was represented by one millimeter of space, and, by subsequent plotting of curves, a graphical record of the speeds at various portions of the road and under various conditions was obtained. Besides the record of speed, these diagrams furnish other valuable information, such as the rate of starting, the time required to attain maximum speed, the time in which stops are made, speed around curves and up grades, and other similar points. Such a speed-recording apparatus should be very useful in connection with indication of locomotives, as the actual speed conditions for the diagrams could readily be obtained after the tests, simply by noting the exact instant of time and then comparing the speed diagram when the cards were being worked up. The simplicity of the device and the readiness with which it can be constructed from existing telegraph apparatus should render its use a matter of small cost.

The Action of the X Rays on the Retina.

IT has hitherto been assumed that the X rays are without action on the retina, although a few observers have asserted that some subjects have experienced a slight luminous impression when placed in the axis of the radiations. A note presented to the French Academy by M. d'Arsonval for M. G. Bardet, and published in *Comptes Rendus* for June 14, records some interesting observations on this point. The assertion has been made that the real reason why no action is felt by the retina is that the eyeball is opaque to the rays, and that this effect is particularly due to the action of the crystalline lens; in proof of this it has been stated that subjects from whom the lens has been removed by the operation for cataract are found to have acquired the capacity of perceiving an action when the rays are permitted to fall upon the retina, although negative results are reported by Darieux. M. Bardet, however, asserts that all the subjects observed by him have been able to experience an action upon the retina, and that the substance of the eye, while probably offering some resistance to the passage of the rays, is not entirely opaque to them. In order that the phenomena should be observed, however, it is necessary that numerous precautions be taken, as the action is very feeble and can be perceived only in absolute darkness. The observer is placed in a closed cabinet, all light being excluded by heavy curtains, and the Crookes tube being placed outside, as the wood and the curtains offer no obstruction to the passage of the rays. No paint whatever should be on the wood, as most colors become more or less fluorescent under the action of the rays, and might cause deceptive results. Under these conditions, when the eye is placed a few inches from the tube without, the retina experiences a luminous sensa-

tion similar to that which occurs when a lighted candle is quickly passed before the closed eyes. This sensation is not interrupted by the interposition of a sheet of aluminum, but is at once stopped by the use of a sheet of iron, copper, or lead. When a piece of glass is interposed, the luminous effect is greatly reduced, but in this case the glass must be without the cabinet, since it becomes fluorescent. The luminous sensations are feeble, but distinct, and are synchronous with the vibrations of the tube, and, when the latter is so turned that the eye is no longer in the axis of the rays, the effect disappears, showing that the impression is not due to the action of the electrical field. All materials which are transparent to the X rays permit also this retinal action, while all those which obstruct their passage cause the luminous impression to cease. In view of the uniformity of these results, M. Bardet thinks that there can be no doubt that the X rays produce an impression upon the retina, the only point as yet undetermined being the possibility that the effects observed may be due to a fluorescence of certain portions of the eye itself.

A New Spanish Cruiser.

EVERYTHING which relates to the naval strength of Spain possesses especial interest at the present time; hence we give, from *La Revue Technique* of July 10, the following particulars of the new armored cruiser Cristobal Colon, which has recently been completed by the Ansaldo works at Genoa, and which successfully passed her speed trial on April 30 of this year. This vessel is claimed to be one of the most powerful fighting machines in Europe. The hull is 328 feet in length by 60 feet beam and 23 feet draft; the displacement 7,000 tons, and the total horse power 14,000. The entire hull is protected by a belt of 15-centimeter nickel-steel armor, above which is a citadel extending two-thirds of the length of the ship, bearing armor of the same thickness, together with two barbettes; these latter carrying each a gun of 254 centimeters' bore, while the battery in the citadel is composed of ten six-inch rapid-firing guns; there are also a number of smaller guns on the bridge and in the tops. The machinery is covered by a curved protective deck of 1 to 1.2 inches thick, extending over the whole length of the ship. The propelling machinery consists of two triple-expansion vertical engines of 6,750 h. p. each, and 500-h. p. auxiliary machinery. The most interesting portion of the motive power, however, is found in the boiler-room. Here are twenty-four water-tube boilers of the Niclausse class, arranged in four batteries, and adapted to work at 200 pounds' pressure, developing 14,000 h. p. The total weight of the boilers, including water, flues, and all auxiliary apparatus, is about 376 tons, giving a weight of about 59 pounds per h. p., or, for the empty boiler alone, about 44 pounds per h. p. This weight is much lower than that possible with the Scotch boiler, and is even lower than that usually attained for water-tube boilers in large vessels. The Cristobal Colon made her first trial on April 28, when, under natural draft, she made 19.35 knots for four hours, the machinery working in a most satisfactory manner. On April 30 a second run was made over a course of 22 miles, when a speed of 19.6 knots was attained, or 1-10 knots more than the requirement. This result was so satisfactory that the Spanish government officials decided that forced-draft trials were unnecessary, and on May 4 an eight-hour run was made to determine the efficiency of the machinery. With an average speed of 18.3 knots, a consumption of 1.62 pounds of coal per horse power per hour was obtained, and the inspectors state that this economy could be maintained continuously without special effort. These figures are of especial interest in comparison with those obtained by previous trials with the Garibaldi, a cruiser built by the same establishment and identical in every respect with the Cristobal Colon, except that the boilers in the Garibaldi are cylindrical. The latter vessel, on her speed trial under conditions similar to those above stated, could not make over 18.3 knots, showing a difference of 1.3 knots, due to the increased efficiency of the boilers. The new

cruiser is an important addition to the Spanish navy and a great credit to her Italian builders.

A Suggestion in Electric Railways.

WHILE doubtless the application of electric motive power will ultimately be extended to regular railway service, it is hardly to be expected that so great a change can be made in a short time. Intermediate steps, however, may be taken which will lead to the accomplishment of that end gradually, and one of those steps may be found in a suggestion of Herr Schiemann in the *Deutsche Zeitschr. fur Elektrotechnik* for June 15. This plan is to construct cheap lines of narrow-gage electric railway along the main highways of merchandise traffic, running upon them low flat top cars upon which ordinary wagons can readily be placed. A train would then consist of these low trucks carrying each a wagonful of goods without horses, and requiring no attention at the destination save that of dismounting and hauling away. Such a road, running through an agricultural country, would enable a farmer to drive his own wagon to the nearest station, and, without handling or unloading, to have the vehicle and its contents picked up and carried at high speed to the market, where local horses would haul it intact to the wharf or market-house. Herr Schiemann thinks that for much of the local and country traffic such a combination of wagon- and railway-hauling would enable merchandise to be transported at rates and under conditions impossible at present, and these light railways would prove valuable feeders for the great trunk lines for many sections of country at present without adequate connections. While the experienced railroad man will see many objections to this apparently primitive suggestion, yet there is no doubt that in many instances such a system would be found to have advantages, particularly in the short hauls that involve expenses for handling which are out of all proportion to the distance. The passenger trolley lines have, in many cities, transformed the commercial relations of various business localities, and made many changes in real estate values and it is possible that some such system of rural merchandise-transportation as that suggested by Herr Schiemann may be developed with equally important results.

Decimal Time Again.

SEVERAL months ago we referred in these columns to the agitation of the question of decimal subdivision of the hour and of the quadrant, and the matter has now been discussed by the *Société des Ingénieurs Civils des France*, a report of the discussion being published in *La Revue Technique* for July 10. In the discussion it appeared that the change was not supported by geographers or by engineers, and that its use would cause far-reaching confusion in many directions. Thus a kilogrammeter-second is the energy necessary to raise 1 kilogram through a height of 1 meter in 1.6666-decimal seconds. In like manner the whole C. G S. system of absolute units would be thrown into confusion, just as that system, after a number of years of effort on the part of scientists throughout the world, is coming into general use These and other objections were discussed at some length, as were also the arguments, *pro* and *con*, concerning the division of the quadrant into 100 degrees; but no definite conclusion was reached, the entire matter being referred to the government commission. There seems to be small doubt, however, that the general sentiment was against the changes, especially in view of the practically universal use of the existing system.

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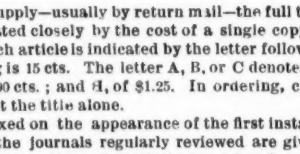
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American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Annales des Ponts et Chaussées. *m.* 31 francs. Paris.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $4 New York.
Architektonische Rundschau. *m.* 18 marks. Stuttgart.
Arena, The *m.* $5. Boston.
Atlantic Monthly. *m.* $4. New York.
Australian Mining Standard. *w.* 30*s.* Sydney.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 6*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Comptes Rendus de l'Academie des Sciences. *w.* Paris.
Contemporary Review. *m.* $4.50. London
Deutsche Bauzeitung. *b-w.* 15 marks. Berlin.
Dingler's Polytechnisches Journal. *w.* 43.60 marks. Stuttgart.
Domestic Engineering. *m.* $2. Chicago
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrochemische Zeitschrift. *m.* 18.40 marks. Berlin.
Elektrotechnisches Echo. *w.* 12 marks. Magdeburg.
Elektrotechniker. *b-m.* 12 marks. Vienna.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.

Engineers' Gazette. *m.* 8*s.* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y
Engineering Journal. *s-m.* 50 cts. Stanford Univ.
Engineering Magazine. *m.* $3. New York
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
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Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
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Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
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Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
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Iron Trade Review. *w.* $3. Cleveland.
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Journal Assoc. Eng. Society. *m.* $3. St. Louis.
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Journal of Gas Lighting. *w.* London.
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Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London.
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence Kan.
La Nature. *w.* 24.50 francs. Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
L'Eclairage Electrique. 60 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
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Le Moniteur des Architectes. *m.* 33 francs. Paris.
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Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
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Marine Engineer. *m.* 7*s.* 6*d.* London.
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McClure's Magazine. *m* $1. New York.
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Mining Journal, The. *w.* £1. 8*s.* London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* fl. 12. Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart
Moniteur Industriel. *w.* 40 francs. Paris.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* 24 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
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Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
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Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Magazine. *m.* $2. New York.
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Railway Press, The. *m.* 7*s.* London.
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Science. *w.* $5. Lancaster, Pa.
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Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
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State's Duty, The. *m.* $1. St. Louis.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago
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Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
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State's Duty, The. *m.* $1. St. Louis.
Western Electrician. *w.* $3. Chicago.
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Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1.50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift für Lokomotivführer. *m.* 5 marks. Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines *w.* 53 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

ARCHITECTURAL Work.

The Work of George Edward Harding & Gooch. A critical review, with illustrations. 4800 w. Arch Rec—July-Sept. 1897. No. 14227 C.

BETON.

Béton Buildings at the Beocsin Cement Works. (Bétonbauten in den Beocsiner Cement Fabriken.) An account of various buildings of concrete, including a concrete tunnel for rope transmission; also rows of workmen's houses. 1 plate. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1897. No. 14152 D.

The Applications of Reinforced Béton. (Les Applications du Béton de Ciment Armé.) Describing the Hennebique construction of T beams of concrete, with iron rods imbedded in the lower portion. 3500 w. Revue Technique —June 25, 1897. No. 14139 D.

BOMBAY.

Dwelling Houses in Bombay. (Wohnhäuser in Bombay.) A. Meissner. An interesting account from personal observation, with especial reference to English work. 1 plate. 3000 w. Oesterr Monatschr f d Oeffent audienst—July, 1897. No. 14153 D.

BOWLING GREEN Building.

See same title under Electrical Engineering, Miscellany.

CHURCH.

Design for a Greek-Catholic Church at Zastavna. (Project für eine Griechisch-Katholische Kirche in Zastavna.) An interesting example of effective wooden church construction. 3 plates. 1200 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1897. No. 14151 D.

Wimborne Minster. S. Beale. Illustrated Description of a Norman church, its altars, tombs, relics, &c. 3000 w. Am Arch—July 10, 1897. No. 13986.

COLUMBIA University.

The University of Columbia. F. M. O'Reilly. Part first is introductory, reviewing the development and the current work. Later articles will describe the architectural features of the various buildings. 2000 w. Engng—July 2, 1897. Serial. 1st part. No. 13964 A.

FERRY House.

New Ferry House at San Francisco, Cal. Illustrated detailed description of new structure being built at the foot of Market St. to accommodate heavy suburban traffic and the main line traffic of the railways. 1800 w. Eng News—July 29, 1897. No. 14331.

FIRE Precautions.

Precautions against Fire in Metallurgical Works. Discusses faults in mill construction, and calls attention to points requiring care. 1000 w. Eng & Min Jour—July 17, 1897. No. 14038.

FIREPROOFING.

Reports of Insurance Companies' Experts on the Pittsburg, Pa., Fire. Parts of reports of interest as indicating the manner in which this fire and its action impressed the insurance experts, and as giving their ideas as to the defects shown to exist in fireproof construction, with editorial. Ill. 6500 w. Eng News—July 15, 1897. No. 14019.

FOUNDATIONS.

Pneumatic Caisson Foundations for the Mercantile Building, New York City. Illustrations and description of features of particular interest. There were nine timber and five steel caissons, and the success and rapidity with which the work was accomplished without disturbing the neighboring structure is worthy of note. 1100 w. Eng News—July 15, 1897. No. 14020.

HOSPITAL.

The Park Hospital, Hither Green, S. E. Illustrated description of a new fever hospital in England. 2500 w. Eng, Lond—July 16, 1897. No. 14260 A.

INDEPENDENCE Hall.

Restoring Independence Hall. Asa M. Steele. An account of the effort being made to restore the group of buildings to their original condition, at the time of the signing of the Declaration of Independence. Ill. 2000 w. Harper's Wk—July 24, 1897. No. 14092.

N. Y. LIFE Building.

See same title under Electrical Engineering, Power.

SCHOOL Building.

A School Building and Town Hall of Moderate Cost. Illustrated description of the Washington school building, situated in West Orange, N. J., planned to be used for a town hall and primary school house. 900 w. Eng Rec—July 17, 1897. No. 14054.

TILE Protection.

See same title under Railroad Affairs, Maintenance of Way.

VAULTS.

Groined Vaults. Discusses the knowledge of vaulting possessed by the builders of the thirteenth and fourteenth centuries, with some reference to earlier work. 2500 w. Arch, Lond —July 9, 1897. No. 14052 A.

HEATING AND VENTILATION.

BLOWER System.

A Blower System of Furnace Heating. Illustrated description of the system of heating and ventilation used in school No. 2, East Albany, N. Y. 1300 w. Met Work—July 31, 1897. No. 14344.

EXHAUST Steam.

Practical Determination of Mean Pressure. Heating with Exhaust Steam. Discusses when it is economical to use exhaust steam, and methods of determining the point at which economy begins. 900 w. Am Elect'n—July, 1897. No. 13896.

GREENHOUSES.

Heating Greenhouses. L. R. Taft, in the *Florists' Exchange*. Extracts from article. Discusses boilers, grate and heating surface, radiation, piping, heating by steam and by steam and hot water combined. 4000 w. Met Work—July 24, 1897. No. 14225.

Hot-water Heating for Greenhouses. J. D. Eisele. Condensed from a paper read before the Philadelphia Florists' Club. Discusses the selection of boilers, the elevated boiler system and the economy. 2000 w. San Plumb—July 15, 1897. No. 14028.

HEATING Apparatus.

See same title under Railroad Affairs, Maintenance of Equipment.

HOT BLAST System.

Automatic Regulation of the Hot-Blast System of Heating in the Racine High School. Illustrated detailed description. 1500 w. Heat & Ven—July 15, 1897. No. 14077.

HOT WATER Heating.

A Hot Water Heating Plant in St. Louis. Illustrated detailed description of hot water plant in residence of Byron Nugent. 2400 w. Eng Rec—July 10, 1897. No. 13956.

HUMIDITY.

The Humidity of the Air. (Die Feuchtigkeit der Luft.) Bruno Griep. Discussing the importance of introducing moisture into artificially warmed rooms, in order that the most healthful proportion may be maintained. 1000 w. Gesundheits Ingenieur—June 30, 1897. No. 14165 B.

LARGE Heaters.

Economical Heating. Claims that large heaters will alleviate many of the ills complained of, and prove economical in consumption. 1200 w. Dom Engng—July, 1897. No. 14233 C.

LILY Pond.

See same title under Landscape Gardening.

POST-OFFICE.

Heating and Ventilation of the Detroit Post-Office. Illustrated description of a plant planned with more than ordinary care. 1700 w. Eng Rec—July 31, 1897. Serial. 1st part. No. 14415.

SHIP Ventilation.

See same title under Marine Engineering.

STEAM Plant.

A High Pressure Steam Plant. F. L. Ray. Some observations on its design and operation. 2700 w. Bos Jour of Com—July 17, 1897. No. 14029.

VENTILATION.

The Choice of Ventilating Systems for Schools, Theatres, Churches, &c. (Die Auswahl des Ventilations-Systems für Schulen, Theater, Kirchen, u. s. w.) A paper read before the sanitary association of Berlin by Prof. Rietschel. 3000 w. Gesundheits Ingenieur—July 15, 1897. No. 14170 B.

WARMING.

The Warming and Ventilating of the Reichstags Building in Berlin. (Die Heizungs-und Lüftungsanlage des Deutschen Reichstags hauses in Berlin.) Karl Schmidt. A very fully illustrated description of this large plant, recently installed in the buildings of the German Capital, at a cost of $200,000. Two articles, 1 plate, 7500 w. Gesundheits Ingenieur—June 15 & 30, 1897. No. 14163 E.

LANDSCAPE GARDENING.

LANDSCAPE Gardener.

The Landscape Gardener and his Work. O. C. Simonds. Extract from an article published in *Park and Cemetery*. On the knowledge essential in successful landscape gardening. 1700 w. Gar & For—July 21, 1897. No. 14091.

LILY Pond.

Heating the Lily Pond in Prospect Park. Describes the arrangements used in the Brooklyn park, making it possible to grow the tropical flowers. Ill. 800 w. Met Work—July 31, 1897. No. 14343.

PARK Maintenance.

One Way to Reduce the Cost of Park Maintenance. Urging the making of parks less pretentious and constructing them in the outset in the most thorough manner, and in such a way that they may be cared for more cheaply. Editorial. 1000 w. Gar & For—July 14, 1897. No. 13995.

TREES.

The Effects of Wind on Trees. J. B. S. Norton. From a paper read before the St. Louis Academy of Science. The results of observations made at the time of the great tornado, and followed by more recent study. 1300 w. Gar & For—July 28, 1897. No. 14311.

PLUMBING AND GAS-FITTING.

ASYLUM.

Some Plumbing in an Insane Asylum. Illustrated description of work at the Willard State Insane Asylum at Willard, N. Y. The noticeable features are the way in which the traps are made safe against syphonage and the treatment of the trap vent pipe system. 1200 w. Eng Rec—July 17, 1897. No. 14055.

BATHS.

Roman Baths. Illustrated description of some of these noted baths, with the customs of the people who used them. 2000 w. Sci Am—July 10, 1897. No. 13908.

LEAD.

Lead. A defense of lead work as used by the plumber, and some of the physical and chemical properties of the metal are given in part first. 1500 w. Dom Engng—July, 1897. Serial. 1st part. No. 14232 C.

PEPPERMINT Test.

Back Vent Connections and the Peppermint Test in Boston. James J. Lawler. Comment on the requirements of the sanitary inspector, growing out of the use of the peppermint test, and suggesting the use of the smoke test in its stead. 800 w. Dom Engng—July, 1897. No. 14231 C.

Preparation for Peppermint Test. Suggestions for arrangements in construction which will permit frequent testing, with directions fo making this test which is in most general use Ill. 600 w. Dom Engng—July, 1897. No 14230 C.

PLUMBING.

Plumbing in the Commercial Cable Building. Illustrated description of the water-supply system. 1600 w. Eng Rec—July 3, 1897. No. 13882.

SANITATION.

American Household Sanitary Appliances. (Ausgeführte Beispiele von Amerikanischen Haus Entwasserungs-Anlagen.) W. P. Gerhard. An excellent description of American bath room plumbing, for the benefit of German readers 5000 w Gesundheits Ingenieur—July 15, 1897. No. 14168 B.

Plumbing and Sanitary Work. S. S. Hellyer. Read before the Architectural Assn., England. Part first discusses plumbing practice in England, with remarks on cost. Ill. 3500 w. Plumb & Dec—July 1, 1897. Serial. 1st part. No. 13984 A.

MISCELLANY.

ARBITRATIONS.

The Practice of Arbitrations. Review by Prof. Kerr, of a work entitled "The Law Relating to Civil Engineers, Architects, and Contractors; with a Chapter on Arbitrations," by L. Livingston Macassey. Considers only the practice of building arbitrations. 4800 w. Jour Roy Inst of Brit Archs—June 17, 1897. No. 14082 A.

BELGIUM.

Belgium: Its History, Art, and Social Life. William Elliot Griffis. An interesting account of this country, with illustrations of the architecture. Ill. 3300 w. Chau—Aug., 1897. No. 14340 C.

BRICK.

Brick versus Wood. R. Clipston Sturgis. The writer proposes to treat briefly, first, the advantages of brick over wood; second, the adaptability of brick to all circumstances of climate and all classes of buildings; and third, a consideration of the means for promoting the more general use of brick. 2000 w. Br Build—July, 1897. Serial. 1st part. No. 14292 C.

BROWNSTONES.

General Features of Brownstones. T. C. Hopkins, in Appendix to the annual report of Pennsylvania State College. Part first gives the chemical composition, structural features, and analysis. 3500 w. Stone—July, 1897. No. 14210 C.

CEILINGS.

Ceilings and Their Decoration. Walter J. Pearce. Suggestions for the treatment of ceilings, with illustrations of designs for stencilling are given in part first. 2500 w. Plumb & Dec—July 1, 1897. Serial. 1st part. No. 13985 A.

COMPETITIONS.

See same title under Economics and Industry, Governmental Control.

CYCLONE.

The Cyclone of June 18. (Le Cyclone du 18 Juin.) An account of the damage done in the vicinity of Paris, with a suggestion as to the imbedding of metal in masonry, in order to resist sudden tensional stresses. 1500 w. Revue Technique—July 10, 1897. No 14142 D.

DERBY, England.

The Architecture of Our Large Provincial Towns. Historical account of this ancient town and its architecture. It has no great building but there is much of interest both old and new. Ill. 3800 w. Builder—July 17, 1897. No. 14254 A.

DRAUGHTSMANSHIP.

Fifty Years of Architectural Draughtsmanship. R. Shekleton Balfour. Comments on the collection of architectural drawings and designs recently on view in the rooms of the Royal Institute. 2200 w. Jour Roy Inst of Brit Archs—June 17, 1897. No. 14083 A.

ENTASIS.

A Discovery of the Entasis in Mediæval Italian Architecture. William H. Goodyear. A study of entasis as employed in columnar and other forms, and explanations of the purpose as given by various writers. Numerous examples are given, and many illustrations. 8000 w. Arch Rec—July-Sept., 1897. Serial. 1st part. No. 14226 C.

INSPECTION.

Building Inspection in New York City. An instance of a building showing signs of weakness is given, that having been strengthened by experienced contractors, proved on inspection, to be worse than at first. Cited as a proof of the necessity of inspection work. 500 w. Eng Rec—July 24, 1897. No. 14276.

MATERIAL.

The Influence of Material on Architecture. Banister F. Fletcher. Prize essay, written for the Inst. of Architects in 1896. Republished as a good résumé of an important aspect of architectural study. Part first consists of introduction; Chap. I. on Egypt: Mud and Reeds to Granite; and Chap. II. on Assyria: Mud to Brick, or Wood to Stone. 2800 w. Builder—July 24, 1897. Serial. 1st part. No. 14420 A.

NON-FLAMMABLE.

See same title under Marine Engineering.

SUMMER School.

An Architectural "Summer School" Abroad. E. B. Homer. An account of the first part of the trip of architectural students who crossed the Atlantic for one thousand miles of bicycle travel in Europe, for the opportunity of architectural study. Ill. 2000 w. Am Arch—July 31, 1897. Serial. 1st part. No. 14416.

TECHNICAL Education.

Technical Education in Architecture and the Building Trades. W. R. Lethaby. Read before the International Congress on Technical Education. Defines architecture and style, reviews the past, and suggests that the unions take up the work of teaching architecture and building. 3800 w. Jour Soc of Arts—July 23, 1897. No. 14396 A.

TEMPLES.

Structural Temples. Cyrus K. Porter. Describes the ancient temples of Egypt, the temple of Jerusalem, the temples of ancient Greece and Rome, the temples of Baalbec, &c. 7000 w. Stone—July 1897. No. 14209 C.

VILLENEUVE.

Villeneuve-les-Avignon. A brief description of the architectural curiosities of this old town in the south of France. Ill. 2400 w. Builder—July 10, 1897. No. 14064 A.

WORKMEN'S Homes.

The Housing of the Working Classes. Dr. Beveridge. Read before the Sanitary Inspectors of Scotland. The difficulties encountered and overcome in Aberdeen. Confined principally to a consideration of air space. 1700 w. San Rec—July 23, 1897. Serial. 1st part. No. 14399 A.

WREN'S Buildings.

Sir Christopher Wren's Buildings. Gives the most complete list of them as prepared by James Elmes. 4200 w. Arch, Lond—June 25, 1897. No. 13871 A.

CIVIL ENGINEERING.

BRIDGES.

ARCHES.

The Iron Arch over the Döblinger Hauptstrasse. (Die eiserne Bogenbrücke über die Döblinger Hauptstrasse.) Carl Stöckl. Description and full analytical investigation of 110 ft. span wrought iron arch on the belt line of the Vienna elevated railway. Two articles, plates of details. 7500 w. Zeitscher d Oesterr Ing u Arch Ver—June 25, July 2, 1897. No. 14115 E.

Trussed Arches with Reduced Horizontal Thrust. (Bogenträger mit Verminderten Hori-Zontalschube.) Prof. J. Melan. Showing arrangements for counter weighting each half of the span, thus making a partial cantilever construction. 1 plate 3500 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1897. No. 14154 D.

BRIDGE Operation.

See same title under Electrical Engineering, Power.

BRIDGE Renewing.

See same title under Railroad Affairs, Maintenance of Way.

CHANNELS.

The Natural Width of River Channels. Observations to determine to what extent the contraction of the waterway at a bridge site may be carried. 1100 w. Ind Engng—June 12, 1897. No. 14089 D.

COLUMBIA Bridge.

See same title under Railroad Affairs, Maintenance of Way.

DRAWBRIDGE.

Third Avenue Drawbridge Across the Harlem River, New York City. Illustrated description of this massive drawbridge. 1500 w. Sci Am—July 17, 1897. No. 14013.

EQUALIZING Gear.

Equalizing Gear for Operating Machinery of a 246½-Ft. Swing Bridge, Chicago, Ill. Describes and illustrates a novel and effective departure in applying the power for the operation of a swing bridge. 500 w. Eng News—July 8, 1897. No. 13950.

GIRDER Bridges.

Standard Plans for 100-Ft. Through Plate-Lattice Girder Bridges; Northern Pacific Ry. Considerations that led to the adoption of this type, and the advantages in its favor. Illustrated description. 1000 w. Eng News—July 8, 1897. No. 13946.

Plate-Lattice Girder Bridge Over Little Missouri River, Northern Pacific Railway. Illustrates standard designs prepared by Mr. K. E. Hilgard, for 100-ft. deck plate girders and 85-ft. through plate-lattice girders, with details. Also describes the most recently built bridge of this type. 1300 w. Eng News—July 15, 1897. No. 14022.

HARLEM Bridge.

Piers and Abutments of the Harlem Ship Canal Bridge. An interesting illustrated description of masonry and caisson construction. 1200 w. Eng Rec—July 24, 1897. No. 14274.

PAINTING.

Painting Metal Bridges. William B. Mackenzie. Results of experiments of the writer are given, and much valuable information. 3500 w. Can Eng—July, 1897. No. 13994.

Paint Tests. Max Goltz. Recommendations, based on study and careful examinations, for painting iron and steel bridges, and other metallic structures. Also discussion. 5500 w. Jour Assn of Engng Soc—June, 1897. No. 14298 C.

REDHEUGH Bridge.

The Redheugh Bridge. Illustrated description of the characteristics of a bridge soon to be rebuilt. The remarkable feature is that the upper and lower members of the girders are respectively gas and water mains. 2200 w. Eng, Lond—July 9, 1897. No. 14057 A.

STREET Railway Bridges.

See same title under Street and Electric Railways.

SWING Bridge.

See same title under Railroad Affairs, Maintenance of Way.

TRUSS Design.

A New Truss Design and Its Analysis. C. L. Strobel. Design, including strain sheet, worked out so as to show the proportioning of parts and the weights and cost, prepared by the writer in connection with the competition for the Sixth St. bridge, Pittsburg, Pa. 1300 w. Eng News—July 22, 1897. No. 14238.

Stresses in Lattice Members in a Parabolic Truss. (Einflusslimen für die Spannungen der Gitterstäbe berin Parabelträger.) Emil Bittner. An analytical investigation for various loads. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—July 16, 1897. No. 14119 B.

VICTORIA Bridge.

The Victoria Bridge, Colombo. Charles Vincent Bellamy. Reasons for removing the Bridge of Boats and for the building of a new structure, with description and information. Ill. 9400 w. Ind & East Eng—June 26, 1897. No. 14293 D.

CANALS, RIVERS AND HARBORS.

CANAL Improvement.

Canal Improvement to Date. Herschel Roberts. Progress of the work under the nine million dollar expenditure. Contracts now under way. Contracts about to be let. Statement of advancement. 4000 w. Sea—July 8, 1897. No. 13923.

CHEZY Formula.

On the origin of the Chézy Formula. $V = c\sqrt{rs}$. Clemens Herschel. A translation of as much of the original Canal de l'Yvette report as refers to the formula in question. Believed to be for the first time printed. 2300 w. Jour Assn of Engng Soc—June, 1897. No. 14299 C.

DEEP-WATER Canals.

Proposed Deep-Water Canals in Germany and Austria. W. Powell. Consular report of the proposed enlargement of the waterway between Stettin and Berlin and other projects. 500 w. Prac Eng—July 9, 1897. No. 14068 A.

DREDGES.

Bucket and Suction Dredge. (Seebagger mit Erinern und Saugrohr.) An illustrated descrip-

tion of the powerful dredge built by Smulders, of Rotterdam for the Russian government for use in the sea of Azov. 1000 w. 1 plate. Zeitschr d Ver deutscher Ing—July 3, 1897. No. 14105 B.

New Hydraulic Dredges for the Mississippi River Improvement. Illustrated detailed description of dredges designed for low water use, where there is no hard material. The rotary cutters have been omitted and powerful water jets are adopted for stirring up the material to be excavated. 2000 w. Eng News—July 22, 1897. No. 14242.

FLOODS.

See same title under Railroad Affairs, Miscellany.

HYDRODYNAMICS.

A General Theory of the Laws of Vortex Motion in Liquids. (Théorié Générale des Régimes Graduellement Variés dans l'Écoulement Tourbillonant des Liquides.) J. Boussinesq. A highly mathematical treatment of the subject, deriving the first approximative formulas. 2500 w. Comptes Rendus—June 8, 1897. No. 14121 D.

Experimental Verification of the Theory of Gradually Varied Flow in Open Channels. (Vérification Experimentale de la Théorie de l'Écoulement Graduellement Varié dans les Canaux Découverts.) J. Boussinesq. Showing a very satisfactory agreement between the theoretical deductions and the experimental results. 3000 w. Comptes Rendus—June 14, 1897. No. 14125 D.

Expression for the Small Transversal Components of the Velocity. (Expression des Petites Composantes Transversale de la Vitesse.) M. Boussinesq. A further contribution to the mathematical theory of the gradually varied flow of liquids. 2500 w. Comptes Rendus—June 21, 1897. No. 14128 D.

The Distribution of Velocities in Large Cross Sections. (Distribution des Vitesses à Travers les Grandes Sections.) M. Boussinesq. A mathematical discussion, continuing the author's previous researches. 2500 w. Comptes Rendus —July 5, 1897. No. 14131 D.

ILLINOIS Streams.

The Streams of Illinois and Their Future Development. Eben J. Ward. Discusses the importance of the improvement of natural water courses, the favorable situation of Illinois, the connection of Lake Michigan and the Mississippi, cost., &c., with discussion. 7000 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14204 D.

PANAMA.

The Present Condition of the Panama Canal. (Etat Actuel des Travaux du Canal de Panama.) Description, with photographs of the existing state of affairs along the line of the works. 3000 w. Revue Technique—June 10, 1897. No. 14133 D.

PROPOSED Harbor.

Proposed Harbor at Licata, Sicily. A. E. Carey. Gives a sketch of a scheme of importance both commercially and scientifically, with plan of the work and statement of existing conditions. Ill. 1300 w. Eng, Lond—July 9, 1897. No. 14058 A.

RHONE Canal.

See Economics and Industry, Commerce and Trade.

RIVER Improvement.

The Regulation of the Elbe and the Saale. (Die Regulirung der Elbe und der Saale.) V. Witasek. With map of the lower Saale, and plan and sections of the dike on the Elbe near Magdeburg, and view of the movable dam at Pretzien. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 2, 1897. No. 14116 B.

VOLGA.

The River Volga. C. H. Moberly. The importance of the river as the great water highway of Russia, with a general description, to be followed with particulars of the several sections, and some account of the rise and development of the navigation. 3000 w. Engng —July 23, 1897. Serial. 1st part. No. 14365 A.

IRRIGATION.

WOODEN Pipe.

Submerged Wooden Pipe and Concrete Diverting Dam for the Rio Grande Dam and Irrigation Co J. L. Campbell. Describes features of a comprehensive system of irrigation, which, if completed, will supply water to 300,000 acres of land. Ill. 2000 w. Eng News—July 15, 1897. No. 14018.

MISCELLANY.

ARCHES.

The Influence of Temperature Changes on Arches (Einfluss von Temperaturschwankungen auf Gewölbe.) J. Herrnanek. Analytical investigation of the stresses and distortions caused by temperature changes. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 2, 1897. No. 14117 B.

BEAM Dimensions.

Beam Dimensions and Load by Diagram. Henry Hess. Method is explained. 1500 w. Mach, N. Y—July, 1897. No. 13899.

CEMENTS.

Tests of Cements. Conclusions adopted by the French commission. Reprinted from the translation by O. M. Carter and E. A. Gieseler, and published by the War Department. 3500 w. Eng Rec—July 10, 1897. Serial. 1st part. No. 13954.

The Annual Meeting of the Association of German Portland-Cement Manufacturers. Abstracted by S. B. Newberry. Report of the meeting including discussions, committee reports, etc., with editorial on the report concerning the action of sea water upon hydraulic cement. 7500 w. Eng News—July 29, 1897. No. 14332.

The German and English Portland Cement Industry. (Die Deutsche und die Englische Portland Zement-Industrie.) Hr. Kaemp. Giving a comparative view of the methods of manufacture, relative growth and value of the efforts of the association of German manufacturers. 3000 w. Zeitschr d Ver deutscher Ing—June 19, 1897. No. 14101 B.

COUNTRY Roads.

A Chapter on Country Roads. A paper by Wm. R. Hoag, on European Roads, presented before the Engs' Club of Minneapolis; a letter

by W. E. Curtis in the *Chicago Record*, stating what is being done by the government; brick and steel roadways, convict labor, etc., are discussed. 6500 w. Brick—July, 1897. No. 13830.

DAM.

Concrete Water-Power Dam at Rock Island Arsenal. Ill. Odus C. Horney. Illustrated description of the construction, and report of a series of tests of importance, also discussion. 6800 w. Jour W Soc of Engs—June, 1897. No. 14306 D.

DECIMAL System.

Decimal Division of the Hour. (Décimalisation de l'Heure.) A discussion of the propositions of the government commission as to the decimal sub-division of the hour and of the circle, by the Society of Civil Engineers of France. 1200 w. Revue Technique—July 10, 1897. No. 14146 D.

DRAINAGE.

Reclamation of the Tiber Marshes. Extract translation from *Gurnale del Genio Civile*, Dec., 1895, with three plans. Describes the delta of the Tiber and the district reclaimed, the work and the great improvement in the sanitary condition. 4200 w. Ind Engng—June 5, 1897. No. 13961 D.

Sluice Box and Flood Gate Construction; Fraser Valley Reclamation, British Columbia. R. E. Palmer. Extract from paper read before the Canadian Soc. of Civil Engs. Describes the design and construction. Ill. 1200 w. Eng News—July 22, 1897. No. 14241.

The Drainage of the Hackensack and Newark Tide Marshes. Plan for the redemption of this waste land as prepared by C. C. Vermeule. The method shuts out the tides by earthen embankments and drains off the water. 1600 w. Eng Rec—July 3, 1897. No. 13879.

Tile Draining in New England. H. N. Brooks. Presents some of the benefits of under draining and a few suggestions for laying drains. 1700 w. Brick—July, 1897. No. 13829.

ELECTRIC Boring.

See same title under Electrical Engineering, Power.

FRAMEWORKS.

Some Fundamental Propositions Relating to the Design of Frameworks. Frank H. Cilley. Discusses the arbitrary nature of the distribution of stress in an indeterminate framework and the economic superiority of statically determined construction. 8500 w. Tech Quar—June, 1897. No. 14283 F.

HIGHWAYS.

American Highways. Charles A. Bell. A résumé of a book by Nathaniel Southgate Shaler, giving intelligent guidance on this subject. 3300 w. Chau—July, 1897. No. 13888 C.

INTEGRATOR.

The Panintegrimeter, an Instrument for measuring Curves and Surfaces. (Panintégrimètre, Instrument pour Mesurer les Courbes et les Surfaces.) Describing the new integrator of Kohlmorgen, a combination of the pantagraph and the planimeter, and of much wider range of uses than the latter instrument. 2500 w. Revue Technique—July 10, 1897. No 14145 D.

MADAGASCAR.

Engineering Work in Madagascar. (Les Travaux du Génie a Madagascar.) Col. Fix. Giving an interesting account of the engineering work planned and partly executed by the French military engineers. Two articles, 5000 w. Revue Technique—June 10 & 25, 1897. No. 14136 F.

RECREATION Pier.

The New Recreation Pier, New York City. Illustrated description of the changes made in the pier at foot of East Third St., which is the first of four piers for recreation which have been projected. 600 w. Eng Rec—July 3, 1897. No. 13878.

SOCIETY House.

The Dedication of the Society House. (Die Feier der Weihe des Vereinshauser.) An account of the dedication ceremonies of the new house of the Society of German Engineers in Berlin, with illustrations of the building and details. 3000 w. Zeitschr der Ver deutscher Ing—June 26, 1897. No. 14102 B.

SUPERSTITIONS.

Traditions and Superstitions Regarding Public Works. Paul Sébillot. Part first consists of introductory remarks, and a chapter on the rites of construction of roads. 2500 w. Ry Mag—June, 1897. Serial. 1st part. No. 13933 C.

SURVEYING.

See Railroad Affairs, New Construction.

TUNNELS.

Electric Rotary Drills on Tunnel Work in France. Abstract from description in *Le Genie Civil* of a plant of the coal-mining company of Bouche-du-Rhone, France. The rock drills are operated by electric power generated by utilizing the water under pressure which is contained in the strata through which the heading is being driven. Ill. 1500 w. Eng News—July 22, 1897. No. 14239.

Guiding Tunnelling Shields. Harley H. Dalrymple-Hay. Remarks on the desirability of adopting some means of directing the course of a shield, with details of a system which has met with some measure of success in a recent example in the City and Waterloo Railway. Ill 2600 w. Ry Wld—July, 1897. No. 14074 A.

VIBRATIONS.

The Vibrations of a Beam under a Moving Load. (Die Schwingungen eines Trägers mit Bewegter Last.) A paper before the German Railway Society by Dr. Zimmermann, discussing the problem by the use of hyperbolic functions. 2500 w. Glaser's Annalen—June 15, 1897. No. 14156 D.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

AMERICAN Machinery.

The Outlook for American Machinery in Great Britain. A summary of recent inquiries among a number of representative dealers and manufacturers in Great Britain. 2700 w. Mach, N. Y.—Aug., 1897. No. 14374.

CHINA.

Revival of the Foreign Trade of China. Re-

port of active trade in both imports and exports. 2800 w. Bd of Trd Jour—July, 1897. No. 14309 A.

The Condition of Trade with China. Editorial calling attention to points in the results of an inquiry undertaken by Byron Brenan, the British Consul at Chefoo. 2500 w. Engng—July 9, 1897. No. 14043 A.

COMPETITION.

Competition—Is it Good or Evil? A. B. Richmond. Discusses what competition accomplishes, its evils and benefits, also co-operation. Generally favorable to competition. 1500 w. Tradesman—July 1, 1897. No. 13866.

CREDIT Protection.

Credit Protecting Unions in Germany. Extracts from the rules and regulations of the association, with other information. 900 w. Bd of Trd Jour—July, 1897. No. 14307 A.

EXHIBITION Warehouse.

First of American Exhibition Warehouses Abroad. Illustrated description of Warehouse being established at Caracas, Venezuela, with a view of stimulating trade. 500 w. Age of St —July 24, 1897. No. 14286.

FRANCE.

The Commerce and Manufactures of France. Yves Guyot. A sketch of the condition of the manufactures and commerce of France, which may be supported by authentic documents. 2200 w. Chau—Aug, 1897. No. 14338 C.

HARBOR.

See same title under Marine Engineering.

IRON Trade.

Progress of the Iron Trade in the Three Leading Countries of the World. Statistics of the production of pig iron in the United States, Great Britain and Germany. 1400 w. Eng News—July 29, 1897. No. 14334.

Statistics of the American Iron Trade for 1896. From the annual report of the American Iron and Steel Association. Interesting information of prices, shipments, consumption, exports, production, etc. 4800 w. Col Guard —June 25, 1897. No. 13836 A.

PATENTS.

Protection to Mechanical Industries. (Maschinen Fabrikauten und Schutzvorrichtungen.) K. Specht. Showing the insufficiency of the existing German patent laws, especially in view of the privileges of the government for the free use of inventions. 2500 w. Zeitschr d ver deutscher Ing—June 19, 1897. No. 14100 B.

PERSIA.

Our Trade with Persia. John Foster Fraser. Explains the cause of the violent fall in British trade with this country, and suggests a remedy. 2300 w. Contemporary Rev—July, 1897. No. 13972 D.

PRICES.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from April 1, 1893, to July 1, 1897, Covering the Period of Recent Extreme Depression. Tables. Bradstreet's—July 10, 1897. No. 13943.

Iron and Steel Prices in 1897. A review of the local iron and steel prices during the first half of the present year. Reports constantly lowering values. 1200 w. Am Mfr & Ir Wld —July 2, 1897. No. 13898.

PROTECTION.

A Broader Philosophy of Protection. Cephas Brainerd, Jr. A reply to article published in the July number, with presentation of the writer's views, and followed by editor's comments. 4500 w. Gunton's Mag—Aug, 1897. No. 14317 C.

RHONE Canal.

The Decadence of the Port of Marseilles and the Proposed Rhone Canal. Discusses the general decadence of French ports, and especially Marseilles, and M. Charles Roux's solution of the problem by connecting Marseilles with the Rhone and so give communication with all the canals and rivers of Europe. 1600 w. Bd of Trd Jour—July, 1897. No. 14308 A.

TARIFF.

Metals in the New Tariff. Provisions of the new tariff act in relation to metals, with comparison of duty under the late tariff. 900 w. Eng & Min Jour—July 31, 1897. No. 14387.

Tariff Changes and Customs Regulations. Russia, Denmark, Belgium, Netherlands, France, Portugal, Spain, Egypt, United States, Mexico, Argentine, China, Trinidad and Tobago. 5500 w. Bd of Trd Jour—July, 1897. No. 14310 A.

The Anatomy of the New Tariff. Charles A. Conant. Discusses the points of difference between the new tariff and the old, the increase of revenue, protection, the different articles most affected, and the attitude of foreign countries. 7000 w. Am Rev of Revs—Aug., 1897. No. 14392 C.

TIRE FABRICS.

The Position of the Tire-Fabrics Trade. Information relating to the output of the past year, prices, fabrics, etc. 1200 w. Ind Rub Wld—July 10, 1897. No. 14410 D.

TRADE Prospects.

A Turn in the Tide. Information from various points showing a general and wide-spread increase in consumptive request, and an encouraging outlook for fall trade. 3500 w. Bradstreet's—July 31, 1897. No. 14385.

TRADE Treaties.

England's Opportunity. Henry Birchenough. A discussion of the new Canadian policy, and the complications connected with it. The treaties of Belgium and Germany, and their bearing upon the question, with suggestion for solving the problem. 3800 w. Nineteenth Cent—July, 1897. No. 13997 D.

GOVERNMENT CONTROL.

ANTI-TRUST Law.

The Decision on the New York Anti-Trust Law. Editorial on the decision of Judge Chester, holding certain sections of the Anti-Trust law, passed by the New York Legislature, unconstitutional. 2800 w. R R Gaz—July 30, 1897. No. 14351.

COMPENSATION Bill.

The Workmen's Compensation Bill. C. A. Montague. Abstract of address before the London School of Economics. States the provisions of industrial insurance in Germany, and

the English bill is briefly discussed. 2000 w. Engng—July 9, 1897. No. 14046 A.

COMPETITIONS.

Regulations as to Government Competitions. Report for the enforcement of the Tarnsey Bill, as given in the Washington *Star*. 1500 w. Arch & Build—July 17, 1897. No. 14079.

JAPAN.

Japan's Patent Requirements. Information concerning the obtaining of patents in Japan furnish d by Jokichi Takamine. Illustration of patent office. 1800 w. Ry Rev—July 10, 1897. No. 13992.

LEGISLATION.

Labor Legislation. Editorial comment on the numerous enactments intended to protect the workman, and the questions now under consideration in England. 2400 w. Engng—July 23, 1897. No. 14367 A.

See Railroad Affairs, Miscellany.

LABOR.

ACCIDENTS Bill.

The Workman (Compensation for Accidents) Bill. Statement with regard to the provisions of the bill, prepared on behalf of the Mining Assn. of Gt. Britain, with account of the views of the Association as presented by a deputation sent to the Prime Minister. 6800 w. Col Guard—July 9, 1897. 14063 A.

BRITISH Workmen.

The British Workingman Under Victoria and Her Immediate Predecessors. Quotes the comments of different writers upon the causes of the prosperity which has characterized this period. 6000 w. Bul of Am Ir & St Assn—July 10, 1897. No. 13990.

EIGHT Hours Day.

Blast-Furnace Men and the Eight Hours Day. Editorial discussion of the complications that arise in considering the management of blast furnaces in this connection. 2300 w. Eng, Lond—July 16, 1897. No. 14261 A.

Blast-Furnace Men and the Eight Hours Day. Editorial presenting the conditions and the difficulties in solving the problem. 1800 w. Engng—July 9, 1897. No. 14044 A.

LABORING Classes.

Labor in the Victorian Age. Reflections on the improved condition of the laboring classes. 2000 w. Jour Gas Lgt—June 29, 1897. No. 13917 A.

LABOR-SAVING Machines.

Do Labor-Saving Machines Deprive Men of Labor? Carroll D. Wright. An interesting discussion of both views of the question, showing that impartial investigation has proved that every fact that seems to show that men have been deprived of labor, can be met by facts showing that more men have been supplied than deprived. 3000 w. Chau—Aug. 1, 1897. No. 14339 C.

STRIKES.

A Practical Remedy for Strikes. Presents the joint conference plan and discusses the advantages. Examples of the successful application of the system are given, and the method used by the Mason Builders Assn. of New York is explained. 3800 w. Gunton's Mag—Aug. 1897. No. 14316 C.

The Dispute in the Engineering Industry. Editorial comment on the present aspect of the strike in the engineering trade in England, to enforce the eight-hours day. 2900 w. Engng—July 16, 1897. No. 14251 A.

The Proposed Pittsburg Mining Agreement. The main points of the agreement which the operators are being asked to sign, in order to secure uniformity. 700 w. Am Mfr & Ir Wld—July 23, 1897. No. 14285.

The Threatened Strike. Editorial discuss on of the threatened strike of engineers, boiler makers and steam-engine makers, in England, to enforce an eight-hour day. 1600 w. Engng—July 2, 1897. No. 13966 A.

MISCELLANY.

AFRICA.

South Africa as a Land of Opportunities. Robert Wallace. Describing the characteristics and resources of the Transvaal and its inhabitants. 7000 w. Eng Mag—Aug. 1897. No. 14400 B.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

CARBORUNDUM.

A Product of the Electric Kiln. Interesting illustrated description of the Carborundum Company's Works, Niagara Falls, N. Y. 2000 w. Brick—July, 1897. No. 13828.

COLD.

Apparatus for the Production of Very Low Temperatures. (Apparat zur Herstellung sehr Niedriger Temperaturen.) A paper read before the convention of the German Electrochemical Association by Dr. Linde, describing the latest form of his apparatus for the liquefaction of air, and the fractional distillation of gases. 2000 w. Zeitschr f Elektrochemie—July 5, 1897. No. 14173 B.

ELECTRO-Deposition.

Electro-Deposition and Recovery of Gold. E. Andreoli. Extract from paper read before the Society of Chemical Industry, London. Gives experiments made by the writer, and a chance discovery which led to a series of tests. 1000 w. Eng & Min Jour—July 24, 1897. No. 14234.

ELECTROLYSIS.

Electrolysis in the Manufacture of Raw Sugar. (Die Elektrolyse in Rohzuckerfabriken.) Gustav Schollmeyer. Describing the operation of the electrical diffusion apparatus used at the refinery at Unter-Berkowitz in Bohemia. 2500 w. Elektrochemische Zeitschr—July, 1897. No. 14177 B.

Methods and Apparatus for the Technical Electrolysis of Alkaline Chlorides. (Verfahren und Apparate zur Technischen Elektrolyse von Chloralkalien.) Leon Hulin. A practical paper based on the results of working experience. 3500 w. Elektrochemische Zeitschr—July, 1897. No. 14176 B.

Notes on the Quantitative Electrolysis of the Heavier Metals. (Beitrag zur Quantitativen Elektrolyse von Schwermetallen.) L. Wolman. Giving a number of methods, with full data as to solutions and currents. A prize essay at the Technical High School at Stuttgart. 4000 w. Zeitschr f Elektrochemie—June 20, 1897. No. 14171 B.

Quantitative Determination of Nitric Acid by Electrolysis. (Die Quantitative Bestimmung der Salpetersaüre durch Elektrolyse.) K. Ulsch. Tests upon known combinations show the method to be both accurate and convenient. 1200 w. Zeitschr f Elektrochemie—June 20, 1897. No. 14172 B.

FURNACE.

Electrical Furnaces. (Ueber Elektrische Oeferr). A paper before the convention of the German Electrochemical Association by Herr Pfleger, with discussion. Interesting data concerning the production of calcium carbid and other products are given. 4000 w. Zeitschr f Elektrochemie—July 5, 1897. No. 14174 B.

LIGHTING.

ARC Circuits.

Switchboards and Station Instruments for Arc Circuits. Alex. Dow. Discusses switchboard construction and details, giving illustrations. 2300 w. Elec Engng—July 15, 1897. No. 14203.

BOLTON, England.

Electric Lighting at Bolton, England. Harold Lomas and Herbert C. Gunton. Illustrated description of a municipally controlled plant. 1800 w. Elec Wld—July 3, 1897. No. 13832.

COILS.

A New Form of Inductive Coil. Elihu Thomson. Describes a new type employing the principle of a "substitute primary" or "secondary primary." Ill. 1500 w. Trans Am Inst of Elec Engs—May, 1897. No. 13931 D.

CONDUCTORS.

The Computation of Conductors for Lighting on the Multiphase System. (Die Leitungsberechnung für Elektrische Beleuchtungsanlagen nach dem Drehstromsystem.) H. Cahen. Showing the best arrangement of conductors for any given system, with formulas and tables for practical use. Two articles. 4000 w. Elektrochemische Zeitschr—June 3 & 10, 1897. No. 14183 E.

DISTRIBUTION.

Distributing Systems. Abstracts of papers by J. A. Jeckell and J. R. Blaikie, read before the Municipal Electrical Assn., and followed by discussion. The merits of the various methods are presented, insulation discussed, and related matters. 3500 w. Eng, Lond—July 16, 1897. No. 14259 A.

ELECTRIC Fountain.

The Electric Fountain at Willow Grove, Philadelphia. Thornton B. Renwell. Illustrated detailed description. 2800 w. Am Elect'n—July, 1897. No. 13892.

GERMANY.

German Central Station Statistics. From the *Elektrotechnische Zeitschrift*. Recent statistics of German central stations giving a record of good work and affording an insight into the tendencies of electrical work in that country. 1200 w. Elec Eng—July 15, 1897. No. 14005.

HOSPITAL Lighting.

Electric Light Plant of the Columbus State Hospital. E. P. Roberts. States the conditions controlling the design, and gives illustrated detailed description. 1500 w. Am Elect'n—July, 1897. No. 13895.

INCANDESCENT Lamps.

The Spectrophotometry of Incandescent Lamps. W. R. Turnbull. Criticism of articles by Dr. W. H. Birchmore and M. A. Edson, with an effort to make clearer the composition of light from different sources, and the meaning of the term "luminosity." 1600 w. Elec Eng—July 8, 1897. No. 13916.

ISOLATED Plants.

Isolated Plants versus Central Stations. Percival Robert Moses. Analytical and classified comparison of results of the two methods, as observed in hotels, office buildings, etc. 3500 w. Eng Mag—Aug., 1897. Serial. 1st part. No. 14406 B.

LAMPS.

220 Volt Lamps. G. D. Shepardson. Abstract of paper read before the Northwestern Electrical Assn. Gives lamp tests and information relating to their life and efficiency, with favorable reports. 1800 w. Elec Eng—July 29, 1897. No. 14346.

LIGHTING Plant.

A Modern Central Station Plant. Frederick L. Ray. Illustrated detailed description of the plant of the Citizens' Electric Light and Power Company, Terre Haute, Ind. 4000 w. Am Elect'n—Aug., 1897. No. 14324.

A Small Lighting Plant for a City Building. Illustrated description of plant installed in the Art Club, Philadelphia. 900 w. Eng Rec—July 24, 1897. No. 14277.

The Hamilton, O., Municipal Plant. W. N. Gray. Remarks on the paper of W. W. Bean, and a correction of his statements in regard to city named. 1600 w. Elec Eng—July 8, 1897. No. 13914.

N. Y. LIFE Building.

See same title under Electrical Engineering, Power.

PORTOBELLO.

The Electric Lighting of Portobello, Edinburg. Report of Prof. Kennedy as prepared for the corporation. 1600 w. Arch, Lond—June 25, 1897. No. 13870 A.

RUSSIA.

Lighting Systems in Russia. M. Lutoslawski. Presents the state of affairs with respect to electric lighting in this country. 1800 w. Elec Wld—July 10, 1897. No. 13940.

SHOREDITCH.

Refuse and Light. Editorial approval of a combined electricity and dust destruction undertaking, with information concerning the plant. 2500 w. Engng—July 2, 1897. No 13968 A.

Shoreditch Electricity Works. Illustrated detailed description of buildings, refuse destructors and boilers, steam and exhaust pipes, generating plant, switchboards, public lighting,

mains, &c. 5200 w. Elec Eng, Lond—July 2, 1897. No. 13969 A.

STREET Lighting.

Public Street Lighting, by H. L. P. Boot; Street Lighting by Means of Rectifiers, by C. D. Taite; Street Lighting by Electricity, by S. E Fedden. Abstracts of three papers read before the Municipal Electrical Association, with discussion. 4000 w. Eng, Lond—July 9, 1897. No. 14060 A.

THREE-PHASE Systems.

Calculation of Lines for Three-Phase Lighting Systems. Hermann Cohen. Abstract of an article in the *Elektrotechnische Zeitschrift*, giving a discussion of this subject and the writer's conclusions. 1600 w. Elec Wld—July 10, 1897. No. 13941.

See same title under Power.

THREE-WIRE 440 Volt Plant.

The Three-Wire 440 Volt Plant of the Canton Electric Light Company. A. H. Perkins. An account of the difficulties and of the considerations that led to the adoption of this system. Ill. 1400 w. Elec Wld—July 10, 1897. No. 13942.

TRANSMISSION Plant.

See same title under Power.

VACUUM Tubes.

Moore Latest Vacuum Tube Lighting Apparatus. Illustrated description of apparatus. 300 w. Elec Eng—July 29, 1897. No. 14345.

VENEZUELA.

Electric Light Plant at Barquisimeto, Venezuela. (L'Installation de l'Éclairage Electrique de Barquisimeto, Venezuela.) Hydraulic power is used, with steam as an auxiliary in times of low water. Interesting effects were observed in the expansion of overhead wires in hot weather. 2000 w. Revue Technique—June 10, 1897. No. 14135 D.

POWER.

BOSTON Southern.

See same title under Railroad Affairs, Terminals and Yards.

BRIDGE Operation.

An Electrically Operated Bridge. J. E. Woodbridge. Describes and illustrates the interesting electrical features of the drawbridge connecting Duluth, Minn., and Superior, Wis. 700 w. Elec Wld—July 3, 1897. No. 13833.

CABS.

The New York Electric Hansom Cabs. Hugh Dolnar. Illustrated description of the hansom cab and its manner of operation, with success of the venture. 1300 w. Am Mach—July 8, 1897. No. 13920.

CONDENSER.

A Condenser System for Electric Power Plants. (Ueber ein Kondensator System für Elektrische Analagen.) Describing a form of independent steam condenser for use in connection with power plants where water is scarce. 2000 w. Deutsche Zeitschr f Electrotechnik—June 15, 1897. No. 14179 B.

DYNAMO.

Determination of the Excitation in Continuous Current Dynamos under Full Load. (Vorausbestimmung der Erregung bei Gleichstrom-dynamos für Vollbelastung.) Emil Dick. Giving analytical and graphical methods for use in the preliminary computations. 2000 w. Elektrotechnische Zeitschr—June 17, 1897. No. 14187. B.

DYNAMO Testing.

See same title under Mechanical Engineering, Engines and Motors.

ELECTRIC Boring.

Electric Boring Installation at Gardonne. M. H. Dubs, in the *Bulletin de la Société Scientifique Industrielle de Marseilles*. Describes the plant used in the construction of a sea canal. 900 w. Eng Rec—July 10, 1897. No. 13955.

ELECTRICAL Printing.

A Complete Electrical Printing Establishment. Illustrated description of the motor plant of the Lakeside Press building, Chicago. 900 w. W Elec—July 3, 1897. No. 13876.

ELECTRICAL Tests.

Power Required for Electrically Operated Wood-working Machinery. Report of tests made by O. G. Dodge at the navy yard at Washington, D. C. 1100 w. Sci Am Sup—July 31, 1897. No. 14296.

ELECTRICITY Works.

Electricity Works. S. T. Harrison. Reviews the conditions under which such works operate, and pointing out some of the difficulties tending to limit further decrease in price, under the present methods of working. 3200 w. Prac Eng—July 23, 1897. No. 14393 A.

INDUCTION Motor.

The Alternating Current Induction Motor. Charles Proteus Steinmetz. Discusses load curves, speed curves, regulation and stability. 7000 w. Trans Am Inst of Elec Engs—May, 1897. No. 13930 D.

MACHINE Driving.

Heavy Machinery Driven by Electric Motors. Illustrated description of power plant of the Farrel Foundry and Machine Co., at Ansonia, Conn. 600 w. R R Gaz—July 23, 1897. No. 14245.

MEASUREMENT.

A Compensator for Measurement of Tension and Volume of Current. (Ein Kompensator für Spannungs-und Strom Messungen.) R. Franke. A convenient rheostat apparatus, explained in diagram and shown also in actual form. 2500 w. Elektrotechnische Zeitschr—June 3, 1897. No. 14185 B.

Measurement of Alternating Current Power. A. F. McKissick. Directions for measuring single-phase, two-phase and three-phase circuits. Ill. 800 w. Am Elect'n—July, 1897. No. 13894.

NIAGARA.

Niagara Power. F. M. F. Cazin. The purpose of the paper is to discuss the features of power absorption from the falling waters as actually practiced, and to indicate a line for improved methods and machinery. 2200 w. Elec Wld—July 17, 1897. No. 14026.

N. Y. LIFE Building.

The Power and Lighting Plant of the New York Life Building. Illustrated detailed description of one of the latest and finest of New York's office buildings, especially the

machinery plant. 2500 w. Elec Wld—July 10, 1897. No. 13938.

POWER Plant.

See Mining and Metallurgy, Coal and Coke.

See same title under Street and Electric Railways.

The Electrical Plant on the Sihl (Das Elektricitäts Werk an der Sihl.) Prof. Wyssling. A very full account of the hydraulic and electric plant near Zurich. Serial. Part I. 2500 w. Schweizerische Bauzeitung—June 12, 1897. No. 14148 B.

The Electric Plant of the Modern Tall Building. Frank A. Pattison. Suggestions as to boiler, steam piping, switchboard, storage battery, etc. 2300 w. Eng Mag—Aug. 1897. No. 14408 B.

SWITCH.

A New Automatic Switch. (Ueber einen Neuen Nebenschluss Automaten.) F. Collischonn. Describing and illustrating the author's improved automatic controller for widely varying loads. 2000 w. Elektrotechnische Zeitschr—June 24, 1897. No. 14188 B.

SWITCHBOARDS.

The Erection of Power Station Switchboards. George Moffat. Discusses the construction and the essentials to meet the requirements. Ill. 1800 w. St Ry Jour—July, 1897. No. 13858 D.

THREE-PHASE System.

Three-Phase Power and Light Plant at Liverpool. Illustrated description of a plant installed for the Liverpool Grain Storage and Transit Company at Bootle, Eng. 2500 w. Elec Rev, Lond—July 23, 1897. No. 14359 A.

TRANSMISSION Plant.

The Riverside Transmission Plant. W. A. Laymon. Illustrated description of an electric transmission and general distributing system for power and lighting. 1800 w. Min & Sci Pr—July 3, 1897. No. 13937.

TROLLEY-CARRIAGE.

A Trolley-Carriage to Run on Common Roads. Gilbert P. Coleman. Illustrated description of a motor carriage now in operation at Greenwich, Conn., which will probably lead to the establishing of a "trolley stage" line. 1300 w. Eng News—July 20, 1897. No. 14336.

TUNNELS.

See same title under Civil Engineering, Miscellany.

UNDERGROUND Mains.

The Localization of Faults in Underground Mains. Robert C. Quin. Discussion of methods and results of large experience. Read before the Municipal Electrical Assn. 1800 w. Elec Eng, Lond—July 23, 1897. Serial. 1st part. No. 14381 A.

WIMSHURST Machines.

Sectorless Wimshurst Machines. S. M. Keenan. Describes how to change a sectored to a sectorless machine, and also different machines constructed by the writer. 1500 w. Am Elect'n—Aug., 1897. No. 14328.

TELEGRAPHY AND TELEPHONY.

CABLES.

A new Recording Apparatus for Submarine Cables. (Sur un Nouvel Appareil Enregistreur pour Câbles Sous-marins.) M. Ader. The oscillations of a fine wire in a permanent magnetic field are photographically recorded. On the Marseilles-Algiers cable, 1600 signals per minute were recorded. 1200 w. Comptes Rendus—June 21, 1897. No. 14129 D.

Protection of Ocean Cables. Alexander Porter Moore. Abstract of communication to *New York Herald*. Reviews the efforts of the government to secure protection of the cables, and the need of wise legislation. 1500 w. W Elec—July 24, 1897. No. 14289.

The Working of Long Submarine Cables. R. M. Sayers and S. S. Grant. Read before a students' meeting of the Inst. of Elec. Engs. The difficulties in the working of cables exceeding 400 or 500 nautical miles in length. 1600 w. Elec Rev, Lond—July 9, 1897. Serial. 1st part. No. 14081 A.

COMMERCIAL Telegrams.

Delivery of Commercial Telegrams at Railway Stations. L. H. Korty. Read before the Assn. of Ry. Telegraph Supts., Niagara Falls, N. Y. Discusses irregularities of delivery, and how best to accomplish an improvement. 1300 w. Elec Rev—July 7, 1897. No. 13839.

FIRE Alarm.

Historical Sketch of the Fire Alarm Telegraph. Adam Bosch. The history of the development of this branch of telegraph work, from 1845 to the present. 7000 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14214 D.

MARCONI System.

The Marconi System of Telegraphy. Additional information about the apparatus used in this system of telegraphy by electric waves. Ill. 2200 w. Elec Rev, Lond—July 16, 1897. No. 14266 A.

PATENT Infringement.

Complaint in the Suit Against the Bell Company for Patent Infringement. Complaint brought by the Western Telephone Construction Company of Chicago, alleging infringement of the Keelyn patent. Gives the bill of complaint. 1200 w. W Elec—July 3, 1897. No. 13877.

PRINTING Telegraph.

The Eaton Photographic Printing Telegraph. C. F. Eaton, Jr. Describes an automatic instrument in which the printing is done by the aid of light and instantaneous photography. 1000 w. Elec Eng—July 8, 1897. No. 13912.

PRIVATE Telephones.

Private Telephone Construction. F. H. Smith. Confined to the systems where no switchboard is used, together with the system with two or more instruments on one circuit. 1500 w. Elec Eng—July 8, 1897. Serial. 1st part. No. 13913.

RECEIVERS.

The Polarizing Telephone Receiver. (Das Polarisiren Telephonischer Empfänger.) J. W. Giltay. Describing the author's form of receiver in which the feeble tone is reinforced by use of a condenser. 3000 w. Electrotechnische Zeitschr—June 10, 1897. No. 14186 B.

The Polarizing of Telephone Receivers. J. W. Giltay. Translated from the *Elektrotechnische Zeitschrift*. An account of experiments and their results, with explanation of observed

phenomena. 3300 w. Elect'n—July 23, 1897. No. 14411 A.

SUBMARINE Telegraphy.

A New System of Submarine Telegraphy. Describes the principal features of an apparatus for the sending and receiving of telegraphic signals on long lines of cable, presented by Charles G. Burke. Ill. 1100 w. Eng News—July 22, 1897. No. 14240.

SYNCHRONOGRAPH.

The Synchronograph. Discussion of paper on this subject, by A. C. Crehore and G. O. Squier. 16000 w. Trans Am Inst of Elec Engs—May, 1897. No. 13928 D.

TELEPHONE Dispatching.

The Telephone Dispatching System of the Akron, Bedford & Cleveland Railroad. F. J. J. Sloat. Describes the system that has been very advantageous under the conditions existing on this road. Ill. 1100 w. St Ry Jour—July, 1897. No. 13856 D.

TELEPHONE System.

The Telephone System of the United Kingdom. F. Charles Raphael. Part first gives the early history with illustrated description of the instruments used. 1400 w. Elect'n—July 2, 1897. Serial. 1st part. No. 13962 A.

MISCELLANY.

ALTERNATORS.

The Effect of Armature Inductance upon the Electromotive Force Curves of an Alternator. W. E. Goldsborough. A series of experiments carried on in the electrical laboratories of Purdue University for the purpose of investigating this subject. Apparatus and method are described and results given. 9500 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14211 D.

ARMATURES.

Winding Drum Armatures. William Baxter, Jr. Illustrates and describes the usual means for winding drum armatures and also an apparatus designed by the writer, showing the advantages of the latter machine. 1200 w. Am Mach—July 29, 1897. No. 14318.

BOWLING GREEN Building.

The Electrical Features of the Bowling Green Building. Illustrated detailed description of construction and equipment. 5800 w. Elec Wld—July 17, 1897. No. 14025.

CAPILLARITY.

Some Electro-Capillary Researches. (Einige Kapillarelektrischer Versuche.) A demonstration by Dr. Nernst of a number of interesting electro-capillary phenomena, before the convention of the German Electrochemical Association. 1200 w. Zeitschr f Elektrochemie—July 5, 1897. No. 14175 B.

CARBON.

Electricity Direct from Carbon. J. H. Hellweg, Jr. Reviews briefly the history of this subject tracing progress to the present time, and gives investigations of the writer. The experimenters think they have proved the production of electricity from carbon direct. 3500 w. Elec Wld—July 24, 1897. No. 14273.

CIRCUIT Breakers.

The Testing of Automatic Magnetic Circuit Breakers. C. M. Clark and C. W. MacMullen. Illustrated description of method of experimenting, apparatus, results, &c. 1400 w. Elec Eng—July 15, 1897. Serial. 1st part. No. 14004.

COIL Winding.

See same title under Mechanical Engineering, Engines and Motors.

CONDENSERS.

Application of Hyperbolic Analysis to the Discharge of a Condenser. Alexander Macfarlane. Mathematical investigation. 2400 w. Trans Am Inst of Elec Engs—May, 1897. No. 13929 D.

COSTS.

What Electrical Energy Costs. Albert B. Herrick. Part first states the operation of the present usual method of determining cost, and in subsequent articles will present what he considers a proper system. 1600 w. Elec Eng—July 8, 1897. Serial. 1st part. No. 13915.

ELECTRICAL Apparatus.

Method of Testing the Magnetic Properties of Iron Used in the Manufacture of Electrical Apparatus. George Moffat. Remarks on the importance and usual methods, with description of instrument designed by the writer. 600 w. Am Mach—July 15, 1897. No. 14011.

ELECTRICAL Code.

National Electrical Code. Sketch prepared by the code committee of the National Conference on standard rules and the committee on press of the Underwriters' National Electric Association jointly. 3800 w. W Elec—July 17, 1897. No. 14049.

ELECTRICAL Effects.

Electrified Matter. Harry L. Tyler. Part first is introductory to a series of chapters aiming to make clear that the electrician has only to deal with a condition. The various methods of electrifying will be considered. 900 w. Elec—July 7, 1897. Serial. 1st part. No. 13922.

ELECTRICITY.

See same title under Marine Engineering.

The Uses of Electricity in Sanitariums and in the Practice of Medicine and Surgery. George H. Guy. Reviews the different applications of electricity in medical practice, with remarks on the degree of success. 3000 w. Chau—Aug, 1897. No. 14337 C.

ELECTRICITY and Magnetism.

A Physical Theory of Electricity and Magnetism. T. Proctor Hall. A theory aiming to supply a simple and easily apprehended physical view of electric and magnetic phenomena. 2000 w. Elec Wld—July 3, 1897. No. 13834.

ELECTRIC Oscillations.

On the Theory of Electric Oscillations in Mutually Inductive Circuits. Edwin J. Houston and A. E. Kennelly. An answer to a question of considerable theoretical importance. 1300 w. Elec Wld—July 10, 1897. No. 13939.

FREQUENCY.

Frequency Transformation. F. Jarvis Patten. Describes an apparatus in which the change in the rate of induction is obtained by a novel form of electro-magnetic motor, which, in conjunction with the currents of altered frequency, determines the degree of transformation. Ill. 1300 w. Elec Eng—July 22, 1897. No. 14217.

FUSES.

Circuit Breakers a Step Backwards in Electrical Progress. Harry H. Cutler. Favors the use of properly constructed fuses, with discussion of facts relating to their use. 2500 w. Am Elect'n—Aug., 1897. No. 14325.

The Design of a Reliable Fuse. J. E. Woodbridge. Discusses the causes of their unreliability and the remedy. 3000 w. Am Elect'n—Aug., 1897. No. 14326.

INDUCTANCE.

The Measurement of Inductance with the Sechommeter. H. N. Allen. An account of a defect found in the sechommeter and its removal, with a comparison of this method with the Rayleigh method of measuring inductance. 1800 w. Elect'n—July 16, 1897. No. 14271 A.

A Suggestion for the Construction of Induction Coils. George T. Hanchett. Practical suggestions for the improvement of these coils. 1200 w. Elec Wld—July 17, 1897. No. 14023.

Mercurial Interrupter for Powerful Induction Coils. (Interrupteur à Mercure pour les Fortes Bobines de Ruhmkorff.) M. Cornu. A note presented to the academy describing the new contact breaker of MM. Ducretet and Lejeune, by which violent sparking is avoided. 1000 w. Comptes Rendus—June 14, 1897. No. 14126 D.

INSULATION.

Armature and Commutator Insulation. William Baxter, Jr. Presents the advantages of double insulation. Ill. 1700 w. Am Mach—July 22, 1897. No. 14221.

The Effect of Heat on Insulating Materials. Putnam A. Bates and Walter C. Barnes. Tests made to determine the real facts. 2500 w. Trans Am Inst of Elec Engs—May, 1897. No. 13932 D.

Weston Voltmeter Resistance Curves. Describes tests of insulation resistance made with this instrument, and manner of deriving curves. 1700 w. Am Elect'n—Aug., 1897. No. 14327.

LIGHTNING.

Two Remarkable Lightning Strokes. (Zwei Bemerkenswerthe Blitzschläge.) In both cases tall factory chimneys without lightning rods were rent vertically, the lightning leaping down the line of iron steps built in the masonry. 1200 w. Elektrotechnische Zeitschr—June 3, 1897. No. 14184 B.

LIQUID Air.

Liquid Air as a Factor in Electrical Development. Elihu Thomson in the Boston *Herald*. Outlines a system worthy of examination by those interested in electrical development. 1000 w. Elec Eng—July 22, 1897. No. 14218.

METERS.

Electricity Meters. T. P. Wilmshurst. Considers the essential conditions of a perfect meter, and discusses some of the most important points. Paper read before the Municipal Electrical Assn. and followed by discussion. 5000 w. Elec Eng, Lond—July 9, 1897. No. 14087 A.

Electric Metering from the Station Standpoint. Caryl D. Haskins. Discusses the accuracy, durability and other essential qualities of meters, and the desirability of their use. 4000 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14212 D.

Prepayment Meters. H. W. Couzens. Read before the Municipal Electrical Assn. Considers the essential features of a prepayment electricity meter, and endeavors to show that its adoption would open important fields for electric lighting. 3000 w. Elec Rev, Lond—July 16, 1897. No. 14268 A.

The New Aron Meter. A résumé of Dr. Aron's paper describing his new meter, with illustrations. 1700 w. Elec Eng, Lond—July 9, 1897. No. 14088 A.

NIKOLA TESLA.

Nikola Tesla, the Electrician. Charles Barnard. An account of his life and work. Ill. 2200 w. Chau—July, 1897. No. 13889 C.

POLE Line.

The Pole Line. Frederic A. C. Perrine. A study of the stresses sustained by a pole line. 4000 w. Elec Engng—July 15, 1897. No. 14202.

RONTGEN Rays.

A New Form of Cathode Discharge and the Production of X-Rays, Together with Some Notes on Diffraction. R. W. Wood. Presents a new method of producing the rays, with its advantage, and describes its behavior. 3300 w. Phys Rev—July, 1897. No. 13976 D.

Apparatus for Roentgen Work. E. A. Robins, in the Photogram. The construction of induction coils and other pieces of apparatus in connection with the production of X-Rays. Ill. 2700 w. Sci Am Sup—July 17, 1897. No. 14015.

Properties of Simple Cathode Rays. (Propriétés des Rayons Cathodiques Simples.) H. Deslandres. Note on investigations made at the Paris observatory, showing that simple cathode rays correspond to simple electric oscillations. 1500 w. Comptes Rendus—June 8, 1897. No. 14123 D.

Röntgen Ray Diffusion Phenomena. Elihu Thomson. Illustrated description of a tube designed by the writer for obtaining strong radiation, and the tests made with it. 900 w. Elec Rev, Lond—July 2, 1897. No. 13952 A.

The Action of the X-Rays on the Retina. (Action des Rayons X sur la Retine.) M. Bardet. Showing that a feeble action is experienced when ordinary light is excluded. 1000 w. Comptes Rendus—June 14, 1897. No. 14127 D.

SAFETY Regulations.

Report on the Dangers of Electrical Generation. Second interim report to the Home Department, of the committee appointed to inquire into and report upon certain dangerous trades, with editorial comment. 7500 w. Elect'n—July 16, 1897. No. 14270 A.

STAGE Use.

Electricity on the Stage. H. Bissing. Comments on the slow progress in adapting electricity to the stage, discusses the objections, and advocates the "bank of coils" in preference to the "individual coil" for traveling use. 1300 w. Elec Wld—July 3, 1897. No. 13831.

THE "FUJI."

See same title under Marine Engineering.

THERMO-ELECTRICITY.

A Dissertation on Thermo-Electricity. J. Warren. It is proposed to briefly describe and sum up the merits of the various types of ther-

mopiles and conclude with a discussion on the thermo-electric powers of various dissimilar metals and their alloys. 1500 w. Elec, Lond—July 23, 1897. Serial. 1st part. No. 14348 A.

TRAINING.

The Training of an Electrical Engineer. Suggestions for the acquiring of such knowledge as will prove most useful to workers in this field. 3200 w. Elec Rev, Lond—July 9, 1897. No. 14080 A.

WAVE Theory.

The Derivation of the Fundamental Laws of Electrodynamics from the Wave Theory. (Die Ableitung des Elektrodynamischen Grundgesetzes aus der Wellentheorie.) Rudolf Mewes. A brief mathematical discussion, based on the investigations of Crookes, Heitz, Mayer, and others. 3000 w. Die Elektrizität—June 19, 1897. No. 14182 B.

WIRING.

Municipal Aids to Wiring. Alfred H. Gibbings. Read before the Municipal Electrical Assn., at Manchester. A short paper, with discussion, presenting the advantage of encouraging the use of electricity. 3000 w. Elect'n—July 9, 1897. No. 14085 A.

MARINE ENGINEERING.

BOILERS AND ENGINES.

ANCIENT Ships.

Some Ships of the Ancients. George Henry Preble. Interesting information of remarkable vessels, including the Arc, the Alexandria, or Alexandrian, and others. 5200 w. Sci Am Sup—July 17, 1897. No. 14014.

BRITISH Navy.

The Queen's Navy, 1837–1897. Abridged from an article by A. Laird Clowes, contributed to the *English Illustrated Magazine*. The changes during the present reign are reviewed. Ill. 1600 w. Ill Car and Build—June 25, 1897. No. 13872 A.

CANADIAN Mail.

The New Canadian Mail Service. Editorial discussing the probabilities of success, and the choice of designs for vessels. 2000 w. Eng, Lond—July 2, 1897. No. 13971 A.

CRUISER.

The Spanish Armored Cruiser "Cristobal Colon." (Le Croiseur Cuirassé Espagnol "Cristobal Colon.") A description of this powerful addition to the Spanish navy, with photographs of the vessel and of her water tube boilers. 2500 w. Revue Technique—July 10, 1897. No. 14144 D.

United States Armored Cruiser Brooklyn Present at British Naval Review. Illustrated detailed description. 1300 w. Marine Engng—July, 1897. No. 13867 C.

DANISH Ferries.

Danish Steam Railway Ferries and Ice-Breaking Steamers. I. C. Tuxen Read at the International Congress of Naval Architects and Marine Engineers. Illustrated description of the special features of these vessels. 2800 w. Engng—July 16, 1897. No. 14252 A.

ELECTRICITY.

Electricity on Board Ship, Principles and Practice. William Baxter, Jr. Part first explains the relation of electricity and magnetism. Diagrams. 2400 w. Marine Engng—July, 1897. Serial. 1st part. No. 13869 C.

FERRY-BOATS.

The New Pennsylvania Railroad Ferry-Boats. Illustrated description of the new double twin-screw ferry-boats built for the new service of this road. 1000 w. Sea—July 29, 1897. No. 14352.

HARBOR.

Windau, as the European Export Harbor of the Siberian Railway. (Windau, der Europäische Exporthafen der Grossen Sibirischen Bahn.) A discussion of the advantages of this Baltic seaport as a terminus from which the exports from Siberia may be handled. 2000 w. Glaser's Annalen—July 15, 1897. No. 14161 D.

HULL Weights.

On Graphic Aid in Approximating Hull Weights. J. Johnson. Read at the International Congress of Naval Architects and Marine Engineers. Gives the system used by the writer and found to be satisfactory. 600 w. Engng—July 23, 1897. No. 14370 A.

LAUNCH.

A Vapor Hunting Launch. Illustrated description of a launch built for H. M. Birge, of Buffalo. 900 w. Sci Am—July 24, 1897. No. 14222.

LIGHTHOUSES.

Lighthouse Progress, 1887–1897. J. Kenward. In 1887 the writer prepared an article on the lighthouse work and progress covering the preceding fifty years. This article covers the past ten years, and both together will give a summary record of what has been attained during the Victorian era. 4000 w. Nature—July 22, 1897. No. 14384 A.

MATERIALS.

Improved Materials of Construction and Their Influence on Design. John Howard Biles. Read at the Inst. of Civil Engs. Engineering Conference. The materials discussed are nickel steel and aluminum as applied to ship design. 3000 w. Ind & Ir—July 16, 1897. No. 14280 A.

"MAYFLOWER."

The Log of the "Mayflower." Governor Bradford's lost "History of Plymouth Plantation." The chapters relating to the passage of the "Mayflower" and the first landing and settlement of the Pilgrims. 2200 w. McClure's Mag—July, 1897. No. 13845.

NAVAL Architecture.

Advances Made in the Mathematical Theory of Naval Architecture. Edward J. Reed. Read at the International Congress of Naval Architects and Marine Engineers. A summary of the progress since 1860. Part first deals with strains and the provisions to withstand them, and with stability. 6800 words. Eng, Lond—July 16, 1897. Serial. 1st part. No. 14262 A.

NAVAL Review.
Royal Naval Review. General remarks upon the review at Spithead, with illustrated descriptions of the battle ships of the first and second classes, and the first-class cruisers are given in part first. 14000 w. Ind & Ir—July 2, 1897. Serial. 1st part. No. 13975 A.

NAVIGATION.
The Second Convention of the German-Austrian-Hungarian Association for Inland Navigation. (Der II Verbandstag des Deutsch-Oesterreichisch-Ungarischen Verbandes für Binnenschiffahrt.) A full account of the recent discussion at Vienna of the inland waterways of central Europe, with a discussion of the plans for extension and improvement. An important paper. 20000 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1897. No. 14150 D.

NON-FLAMMABLE.
Non-Flammable Wood. Charles E. Ellis. Read at the International Congress of Naval Architects and Marine Engineers. The process is described and tests reported, with some discussion of the use of such wood in naval architecture. 2000 w. Engng—July 9, 1897. No. 14042 A.

ON Shipboard.
At Sea on the Atlantic. Henry Hall. A mental glimpse of a voyage to Europe, confined to the experience on shipboard. Ill. 2800 w. Chau—July, 1897. No. 13890 C.

PROGRESS.
The Progress of Marine Engineering. Albert J. Durston. Read at International Congress of Naval Architects and Marine Engineers. A review of the history and progress in the Royal Navy and Mercantile Marine from the foundation of the Institution of Naval Architects to the present date. 2400 w. Engng—July 9, 1897. Serial. 1st part. No. 14047 A.

PROPULSION.
High-Speed Screw Propellers. Sydney W. Barnaby. Read at the International Congress of Naval Architects and Marine Engineers. An explanation of the theory of the formation of cavities in water by screw propellers at high speeds. 2200 w. Engng—July 16, 1897. No. 14250 A.

Screw Propulsion. Editorial regretting that Mr. S. Barnaby's paper on "Cavitation" was not adequately discussed, with a criticism of the views set forth by the writer. 1500 w. Eng, Lond—July 23, 1897. No. 14395 A.

RESISTANCE.
Skin-Resistance. H. S. Hele-Shaw. Read at the International Congress of Naval Architects and Marine Engineers. Gives experiments on the nature of surface resistance in pipes and on ships. Apparatus used is described and results given. 4000 w. Engng—July 16, 1897. No. 14253 A.

SHAFTS.
Crank and Other Shafts Used in the Mercantile Marine. G. W. Manuel. Read at the International Congress of Naval Architects and Marine Engineers. Discusses the cause of some of the failures, giving results of experience. Ill. 2300 w. Ir & St Trds Jour—July 17, 1897. No. 14248 A.

SHIP Design.
The Practical Application of Model Experiments to Merchant Ship Design. Archibald Denny. Abstract of paper presented at the recent Engineering Conference, in London. Shows how tank experiments are practically applied, and their value. Brief report of discussion. 2500 w. Steamship—July, 1897. No. 13983 A.

SHIP Ventilation.
The "Boyle" System of Ship Ventilation. Illustrated detailed description. 800 w. Steamship—July, 1897. No. 13982 A.

SPITHEAD.
The Review at Spithead. A summary of the features of the fleet, the cruisers, gunboats, torpedo boats, training ships, &c., also the foreign war vessels and merchant steamers. Ill. 3000 w. Eng, Lond—June 25, 1897. No. 13848 A.

STEAMBOATS.
Early Steamboats on Western American Rivers. Cons. D. Millar. Historical review of steamer traffic on the Ohio and Mississippi. Ill. 4100 w. Eng Mag—Aug., 1897. No. 14404 B.

STEAMSHIP.
S. S. "Clan Macdonald." Illustrated description of a screw-steamer, the first of four sister "Turret" vessels building for a Glasgow Co. 2200 w. Eng's Gaz—July, 1897. No. 13924 A.

The Screw Steamers "Pointer" and "Spaniel." Illustrated description of two recently built coasting steamers, for service from the Clyde to Belfast, Liverpool, and Manchester. 1400 w. Engng—July 2, 1897. No. 13965 A.

THE "FUJI."
Electrical Equipment of the Fuji. Charles E. Grove. Reprint from the *Thames Ironworks Gazette*. Describes the electrical equipment of this Japanese warship in a way to indicate to general readers what the work is like. Ill. 2000 w. Elec Eng, Lond—July 16, 1897. No. 14269 A.

UNITED STATES Navy.
The Steam Navy of the United States. Review of book by Frank M. Bennett, treating of the growth of the steam war vessel of the United States, giving information obtained therefrom. 3000 w. Trans—July 9, 1897. No. 14050 A.

WARSHIPS.
The Progress of British Warships Design. P. H. Colomb. Discusses the changes in design, armament, speed and endurance, favoring the development of the torpedo vessel. 3500 w. N Am Rev—Aug., 1897. No. 14421 D.

WEBB Home.
A Ship-Builder's Dual Monument. Illustrated description and information concerning the academy and home for ship-builders, built and endowed by William H. Webb. 2300 w. Harper's Weekly—July 10, 1897. No. 13921.

YACHTS.
Some Notable Steam Yachts. Illustrated descriptions of the "Andria" and the "Mayflower," which have recently been built in Scotland for American owners. 900 w. Sci Am—July 10, 1897. No. 13907.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILERS.

Steam Boilers with the Dubian Circulating Pump. (Damp f Kessel mit Dubiamscher Rohrpumpe.) Describing a siphon pump arrangement for use with boilers to maintain a positive circulation, with illustrations and numerous tables of tests. 5000 w. Zeitschr d Ver deutscher Ing—July 10, 1897. No. 14111 B.

CARE of Boilers.

Boilers Taking Care of Themselves. How to Wash-Out Boilers. Henry J. Raps. Treats of locomotive boilers, their proper care and inspection while in service; how to make heavy repairs, etc. 2400 w. Loc Engng—July, 1897. No. 13842 C.

CONDENSER.

A Combined Surface Condenser and Water-Cooler. Illustrates and describes a new apparatus designed and patented by Edward F. White. 900 w. Eng News—July 8, 1897. No. 13949.

DRAFT.

Mechanical Draft. Walter B. Snow. The First of a series of articles of interest to all who have to do with steam generating plants. 2200 w. Mach, N. Y—Aug., 1897. Serial. 1st part. No. 14376.

ECONOMIZERS.

Boiler Tests at the Armour Packing Co., Kansas City, Kan., Showing Per cent. of Saving by Use of Economizers. F. G. Gashe. Tests of the plant known as "Boiler House, No. 5." There are three Stirling boilers, Class A, equipped with Johns' mechanical stokers. The object of the trials was to obtain a measure of the benefit from the application of the Green fuel economizer. 2200 w. Power—Aug., 1897. No. 14354.

FUEL.

Petroleum as Steam Engine Fuel. J. A. F. Aspinall. Read before the Inst. of Civ. Engs. England. Reviews the advantages and pronounces the only difficulty to be the question of supplying fuel at a reasonable price. 1300 w. Ir Age—July 8, 1897. No. 13891.

PRESSURE.

Reducing Pressure on Shell Boilers. From *The Locomotive*. An explanation of the rumors that shell boilers are liable to a speedy and gradually increasing reduction of allowable working pressure, with discussion of the change in methods and manufacture necessary to meet the tendency toward high pressures. 2400 w. Ir Trd Rev—July 8, 1897. No. 13951.

REPAIRS.

How Not to Make Heavy Repairs on Locomotive Boilers. Henry J. Raps. Discusses the causes of injury, and the importance of proper care of a boiler. 2500 w. Loc Engng—Aug., 1897. No. 14360 C.

SAFETY Valves.

Safety Valve Practice. W. H. Booth. Calling attention to the importance of pressure, and referring to some notes made sixteen years ago. 1100 w. Am Mach—July 15, 1897. No. 14009.

The Lever Safety Valve. C. A. Collett. Presents methods of finding the proper area for a lever safety valve orifice, as given by different authorities, and gives the writer's opinion that lever safety valves should be consigned to the scrap heap, and pop valves substituted. 2200 w. Am Elect'n—Aug., 1897. No. 14330.

STEAM.

The Generation of Steam. Two papers by John F. Snell and J. J. Steinitz, with discussion, as presented at the convention of the Municipal Electrical Assn., at Manchester, Eng. The first writer discusses the types of boilers in use, with details; the second writer considers the type of boiler, fuel, water, stoking, and boiler adjuncts. 8800 w. Elec Eng, Lond—July 2, 1897, No. 13970 A.

WATER.

The Chemistry of Water. George H. Pattison. Explains the chemical formula of water and studies each gas separately. 2000 w. Power—Aug., 1897. No. 14355.

COMPRESSED AIR.

AIR COMPRESSION.

Experiments on a Two-Stage Air Compressor. John Goodman. Contributed to the Inst. of Civ. Engs. Devoted to a description of tests and methods of reducing the results. Ill. 3200 w. Col Guard—July 23, 1897. No. 14363 A.

The Compression of Air by the Direct Action of Water. Herbert W. Umney. Read before the Society of Engineers. Presents an improved method of compressing air, suitable for adoption in the case of low water falls, and of less expense than by other means. 3300 w. Prac Eng—July 16, 1897. No. 14265 A.

EXPLOSIONS.

Compressed Air Explosions Caused by Ignition. A letter of inquiry from Henry Fisher, of Nottingham, Eng, with editorial reply concerning the cause. 1400 w. Compressed Air—July, 1897. No. 14300.

HAULAGE.

See same title under Railroad Affairs, Miscellany.

LIQUID Air.

See same title under Electrical Engineering, Miscellany.

PORTABLE Compressed Air.

Power of Portable Compressed Air. Frank Richards. Inquiry and reply concerning the use and cost of compressed air as a motive power. 1700 w. Am Mach—July 29, 1897. No. 14320.

USES.

Uses of Compressed Air. J. C. Ransom. Reviews the development of the past few years, and the future possibilities. 2200 w. Tradesman—July 15, 1897. No. 14071.

ENGINES AND MOTORS.

CLEARANCE Spaces.

Large Cylinder Clearance Spaces. Editorial aiming to show that practice which is unquestionably good for stationary engines may be entirely

wrong for locomotives. 1000 w. Loc Engng—July, 1897. No. 13844 C.

COIL Winding.

Magnet and Coil Winding. J. Mason Knox. Illustrates and describes the Varley Duplex Magnet Company's new automatic magnet and coil winder. 800 w. Elec Rev—July 7, 1897. No. 13838.

DYNAMO Testing.

Testing Dynamos. Part first discusses the indicator method. 1400 w. Am Elect'n—Aug., 1897. No. 14329.

ELECTRIC Machinery.

Efficiency of Dynamo-Electric Machinery. Alfred E. Wiener. A study of the electrical efficiency, commercial or net efficiency, efficiency of conversion, and weight efficiency and cost of dynamos. 2000 w. Am Elect'n—July, 1897. No. 13893.

GAS Engines.

Gas Engines. W. F. Kelly. Read before the Engineers' Club, Columbus, Ohio. Information concerning the efficiency, mechanical features, cost, use, &c. 3500 w. Am Gas Lght Jour—July 5, 1897. No. 13841.

HEAT MOTOR.

The Diesel Rational Heat Motor. (Diesel's Rationeller Wärmemotor.) A paper read before the recent meeting of the Society of German Engineers at Cassel, by Herr Rudolf Diesel, describing an improved petroleum motor of high efficiency. Two articles. 10000 w. Zeitschr d ver deutscher Ing—July 10 & 17, 1897. No. 14107 E.

MOTOR.

See same title under Street and Electric Railways.

PISTONS.

Diagrams of Piston Position, Velocity and Acceleration. Part first considers the mechanism of the steam engine, crank and connecting rod, piston position: exact formulæ. Mathematical discussion. 2500 w. Prac Eng—June 25, 1897. Serial. 1st part. No. 13846 A.

PUMPING Engines.

The Pumping Engines at the New High Bridge Pumping Station, New York City. An illustrated description of a modern high-pressure pumping plant. 700 w. Power—Aug., 1897. No. 14353.

STEAM.

Experiments on Superheated and Saturated Steam. From Inst. C. E.: Foreign Abstracts. Reports experiments on a Sulzer compound condensing steam engine at a cotton mill in Bavaria, undertaken to test the economy with the separately-fired Schwoerer superheater. 1300 w. Eng—July 10, 1897. No. 14056.

TURBINES.

Recent Turbines. (Neuere Turbinenanlagen.) A. Pfarr. Detailed descriptions of a number of important installations of vertical and horizontal turbines, with plate of details of the 7 foot turbine of the Girard type for the Cape Town electric plant. 7500 w. Zeitschr d ver deutscher Ing—July 10, 1897. No. 14108 B.

Steam Turbines. Some remarks on the three well known types of steam turbines, the Parsons, the Dow, and the De Laval, and their successful use in driving electrical machinery. Ill. 1500 w. St Ry Rev—July 15, 1897. No. 14099 C.

The Steam Turbine Engine. J. D. Bailie. Abstract of a paper read before the North Staffordshire Inst. of Min. & Mech. Engs. Presents the advantages claimed for this type, and for the turbo-electric generator. 1300 w. Col. Guard—July 16, 1897. No. 14256 A.

The Use of Turbines with a Horizontal Shaft for Running Dynamos. From *Le Genie Civil.* Illustrated description of some special turbines designed for the running of dynamos. 1800 w. Sci Am Sup—July 10, 1897. No. 13909.

POWER AND TRANSMISSION.

CABLEWAY.

The Britts Landing Cable Hoist and Quarry. R. D. Seymour. A successful illustration of one of the uses to which a cableway can be applied, with illustrated description of quarry and means of working it. Discussion follows. 4200 w. Jour W Soc of Engs—June, 1897. No. 14304 D.

CHARGES.

An Inexpensive Method of Determining Charges for Public Use of Large Streams, in a Measure Proportionate to the Amount of Water Used. F. H. Crandall. Describes the use of a small meter placed in a by-pass. 900 w. Jour N Eng Water Works Assn—June, 1897. No. 13864 F.

FLYWHEEL Explosion.

Flywheel Explosion at the Power House of the Tacoma Ry. Co., Tacoma, Wash. A. Mc L. Hawks. Description of accident which took place on July 11, 1897. Ill. 700 w. Eng News—July 29, 1897. No. 14333.

PIPING.

Piping for High-Pressure Steam-Power Plants. A description of the various kinds of pipe, fittings, valves and gaskets, with the well-known methods of making joints and some of the advantages and disadvantages of each. 3000 w. Power—Aug., 1897. No. 14356.

ROPEWAYS.

Wire-rope Transportation. Illustrated brief description of the two general classes of these aerial ropeways, and their advantages. 700 w. Ir & Coal Trds Rev—July 2, 1897. No. 13926 A.

SCOOP Wheel.

A New Scoop Wheel for Raising Water—Paul's System. (Neues Schöpfrad, System Paul, zur Entwässerung von Niederungen.) An example of one of the most recent forms of apparatus for raising large quantities of water over a low lift, as extensively used in Holland. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—June 18, 1897. No. 14114 B.

STEAM.

The Cost of Steam Power. Horatio A. Foster. Describes the methods pursued in testing the plants reported, with tabulated data of results and general information. 7000 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14215 D.

TRANSMISSION.

Rope Transmission. Staunton B. Peck. The paper does not consider wire rope, but discusses briefly the "English System," and more particularly the "American System." Ill. 12500 w.

Jour W Soc of Engs—June, 1897. No. 14305 D.

Shafts, Belts and Pulleys. W. Barnet Le Van. Directions and statements helpful in securing the best results. 2200 w. Eng, N. Y. —July 24, 1897. No. 14290.

WATER Power.

Water-Ram in the Supply Mains of Hydraulic Power Plants. John Richards. An account of some of the difficulties experienced on the Pacific coast in the development of water power under great heads, with editorial discussion. 4500 w. Eng News—July 8, 1897. No. 13947.

SHOP AND FOUNDRY.

BABBITT Metals.

Babbitt Metals. C. Vickers, in *Machinery*. Proportions for a number of alloys are given with general information. 700 w. Sci Am Sup —July 10, 1897. No. 13911.

BICYCLES.

An American Bicycle Manufactory. An illustrated detailed description of the Works of the Pope Company. 3300 w. Engng—July 16, 1897. Serial. 1st part. No. 14249 A.

BIG Guns.

Big Gun Manufacture. Henry A. Wiley. Describes the work as carried on at the United States naval gun factory at Washington, D. C. 2800 w. Age of St—July 3, 1897. No. 13837.

CHUCKS.

Split Chucks. Describes a holder for split chucks for any lathe. Ill. 900 w. Am Mach —July 22, 1897. No. 14220.

ELECTRICAL Apparatus.

See same title under Electrical Engineering, Miscellany.

ELECTRICITY.

Electricity in the Modern Machine Shop. Louis Bell. The new processes based on the use of the electric current. Ill. 3100 w. Eng Mag—Aug, 1897. Serial. 3d part. No. 14403 B.

FOUNDRY Chemistry.

Foundry Chemistry in Practice. Letter from foundry in the northwest, engaged in the manufacture of agricultural machinery. Details concerning the use made of chemical analysis. 800 w. Ir Trd Rev—July 29, 1897. No. 14347.

FOUNDRY Irons.

Comparative Fusibility of Foundry Irons. Thomas D. West. Read before the Pittsburg Foundrymen's Assn., June 28, 1897. A valuable paper giving experiments and results, with description of test cupola used. Also discussion. 3000 w. Ir Trd Rev—July 1, 1897. No. 13826.

GEARS.

A New Line of Automatic Gear Cutting Machines. Illustrated description of machines of the Brown & Sharpe Mfr. Co. 900 w. Am Mach—July 15, 1897. No. 14010.

Cox's Strength of Gears Computer. Illustrated description of an instrument for calculating the strength of toothed gears, with a set of tables for working out questions connected with gearing. 400 w. Am Mach—July 29, 1897. No. 14321.

Spur Gear Arithmetic. Arthur B. Babbitt. The object of the article is to explain in as clear a manner as possible the underlying principles of gearing, and give concise rules or formulæ for the solution of problems. 1200 w. Mach, N.Y.—July, 1897. Serial. 1st part. No. 13900.

MODERN Shops.

One of the Modern Shops. Illustrated description of the new shops of the Garvin Machine Co., at Spring and Varick streets, New York. 1300 w. Mach, N. Y.—July, 1897. No. 13901.

POWER.

The Care and Oversight of the Power Plant. T. Carpenter Smith. Hints to superintendents regarding the management of men and machinery. 3700 w. Eng Mag—Aug., 1897. No. 14405 B.

RIVET Holes.

Spacing Rivet Holes. John Randol. Describes the way this problem was solved by Mr. Aue, superintendent of the De La Vergne shops. Ill. 1300 w. Am Mach—July 22, 1897. No. 14219.

SAND-SIFTING.

New Patterns of Sand-Sifting Machinery. George D. Rice. Drawings and descriptions of several new styles, not patented. 800 w. Mach, N. Y.—July, 1897. No. 13902.

TOOLS.

Machine Tools at the Leipzig Exhibition 1897. (Werkzeugmaschinen in der Gewerbeausstellung zu Leipzig, 1897.) Hermann Fischer. The first instalment of a description of recent German machine tools. The Chemnitz makers have followed American models closely. Serial, Part I. 5000 w. Zeitschr d Ver deutschr Ing —July 17, 1897. No. 14112 B.

Punching and Shearing Machines. From *Revue Industrielle*. Illustrated description of a combined punching and shearing machine, and a simple shearing tool for profiled iron and steel. 1000 w. Sci Am Sup—July 10, 1897. No. 13910.

The Working of Steel. (Ueber Stahlwechsel.) Hermann Fischer. Discussing especially modern machine tools for the rapid production of duplicate work in steel with sketches of details from the practice of various countries. 7500 w. Zeitschr d ver deutscher Ing—June 26, 1897. No. 14103 B.

WORKSHOPS.

Works Management. On the management of engineering workshops. General principles with some suggestions of detail. 2800 w. Engng— June 25, 1897. No. 13851 A.

MISCELLANY.

AEROPLANE.

Experiments with a Steam Aeroplane. (Expériences Faites avec un Aéroplane mû par la Vapeur.) MM. Tatin & Richet. An aeroplane propelled by steam, and weighing 72 pounds, travelled 450 feet in 7¾ seconds. 1000 w. Comptes Rendus—July 5, 1897. No. 14132 D.

ALUMINUM.

Aluminum in Knitting Machinery. George D. Rice. Information useful to knitting machine builders who wish to try this new metal. Ill. 800 w. Mach, N. Y.—Aug., 1897. No. 14375.

Tests of Utensils of Aluminum. (Essai des Utensiles en Aluminium.) M. Balland. Giving the results of chemical tests made upon the cooking utensils of aluminum supplied to the French Army. Comptus Rendus—June 8,1897. No. 14124 D.

AUTOMOBILE.

The Scott Automobile Carriage (Der Scott'-sche Zug.) Illustrated description of the Scott steam traction carriage for regular train service. 2000 w. Oesterr Monatschr g d Oeffent Baudienst—July, 1897. No. 14155 D.

CARDBOARD.

Machines for Treating Paper. (Outillage qui Transforment le Papier.) An illustrated description of improved machines, principally for cutting, and embossing cardboard, &c. 1500 w. 1 plate. Revue Technique—June 10, 1897. No. 14134 D.

GAUGING.

The Gauging of Casks. (Du Jaugeage des Tonneaux.) D. Dujon. Discussing the existing formulas, and especially the gauging of partially filled casks both when on end and lying on the side. 2000 w. Revue Technique—July 10, 1897. No. 14147 D.

GIANT See-Saw.

A Giant See-Saw, for the Tennessee Centennial Exposition, Nashville, Tenn. Gilbert P. Coleman. An illustrated description of an engineering novelty which the promoters aim to make as prominent as the Ferris wheel at Chicago. 700 w. Eng News—July 8, 1897. No. 13948.

HEAVY Guns.

Evolution of the Modern Heavy Gun. W. LeConte Stevens. Historical review of the progress in the construction of materials used in warfare; confined principally to the evolution of the cannon. Ill. 5800 w. Pop Sci M—June, 1877. No. 14423 D.

INDIA-RUBBER.

The Testing of India-Rubber Goods. Discusses the drawbacks to chemical analysis, and gives specific cases where physical tests were made to give a fair criterion of the quality without unfitting the articles for sale. 2000 w. Engng—July 23, 1897. No. 14369 A.

INVENTION.

Forecasting the Progress of Invention. William Baxter, Jr. Discusses the lines along which great development is expected, showing that the expectations in regard to some of them will never be accomplished, because they are impossible, and that others are not likely to be realized. 3500 w. Pop Sci M—July, 1897. No. 14424 D.

MEASUREMENTS.

The English and Metric Systems. Charles T. Porter. A defense of the English system, showing its convenient features and the inadaptibility of the metric system to many uses. 3500 w. Loc Engng—July, 1897. No. 13843 C.

PUMPING.

See same title under Municipal Engineering, Water Supply.

PUMPS.

About Suction Pumps. Remarks on the construction and functions of a steam pump, the suction pipe and its proper size. 1700 w. Bos Jour of Com—July 31, 1897. No. 14364.

The Design of Centrifugal Pumps. J. Richards. An article in two parts treating the subject from the standpoint of a practical builder and designer, and containing much valuable information. Ill. 4200 w. Eng. News—July 29, 1897. Serial. 1st part. No. 14335.

RIVETING.

Experiments on the Frictional Resistance of Riveted Joints. (Untersuchungen über den Reibungwiderstand von Nietverbindungen.) An account of the very important tests made in Holland by J. Schroeder Vander Kolk for the Dutch government, with many diagrams and details for various kinds of riveting under different conditions. Two valuable papers. 12000 w. Zeitschr d ver deutscher Ing—June 26, July 3, 1897. No. 14104 E.

SKETCHES.

The Art of Making Mechanical Sketches for Marine Engineers. C. W. MacCord. Part first shows the importance of a knowledge of the principles of mechanical drawing and gives some suggestions for free-hand sketches. 1000 w. Marine Engng—July, 1897. Serial. Part 1st. No. 13868 C.

TECHNICAL Education.

Reforms in the Organization of Technical Education. Silvanus P. Thompson. Suggests the need of getting rid of the wrong use of the term, the adaptation to the needs of the various industries, the development of breadth of view and capacity in those trained, the proper selection of subjects, &c. 28000 w. Jour Soc of Arts—July 23, 1897. No. 14397 A.

The Development of the Mechanical Engineer. (Zur Ausbildung der Maschinen-Ingenieure.) A symposium upon the subject of engineering education by members of the German Society of Mechanical Engineers, including the opinions of such men as Stambke, Leissner, von Borries, Vogel and others. 12000 w. Glaser's Annalen—July 1, 1897. No, 14158 D.

Theory and Practice in Trade Teaching. Philip Magnus. Paper read at the International Congress on Technical Education. A few suggestions for trade teaching, with consideration of the difficulties. 3800 w. Jour Soc of Arts—July 9, 1897. No. 14070 A.

TEXTILE Machinery.

The Textile Machinery at the Leipzig Exhibition, 1897. (Die Maschinen für die Textilindustrie auf der Gewerbeaustellung zu Leipzig, 1897.) G. Rohn. The first of a series of articles describing the progress of textile machinery in Saxony, as exhibited at Leipzig. Serial. Part 1. 3500 w. Zeitschr d ver deutscher Ing—July 10, 1897. No. 14109 B.

U. S. Machinery.

Prospects for United States Machinery in Belfast. Reply of Consul James B. Taney to inquiries relative to road building and earth-moving machinery. 1000 w. Cons Repts—July, 1897. No. 13927 D.

MINING AND METALLURGY.

COAL AND COKE.

ALABAMA.
Mineral Production of Alabama William M. Brewer. Comments on recent statistics of coal, coke and iron and information of the mines, production, etc. Am Mfr & Ir Wld—July 9, 1897. No. 13979.

BRITISH Coalfields.
Notes on British Coalfields. Part first is devoted to the Great Northern Coalfield. dealing principally with the geological features. 1500 w. Ir & Coal Trds Rev—June 25, 1897. Serial. 1st part. No. 13905 A.

COAL Producing.
Continental Coal-Producing Countries—Their Progress and Prospects. Part first discusses the production and consumption in France. 1000 w. Ir & Coal Trds Rev—July 9, 1897. Serial. 1st part. No. 14086 A.

COAL Seams.
A Geological Curiosity. H. N. Sims. An illustrated description of a peculiar split in the mammoth coal seam near Ashland, Pa. 700 w. Col Eng—July, 1897. No. 13999 C.

DUSTY Coals.
Separation of Dusty Coals. M. Parent. From a communication to the *Annales des Mines*. Describes appliances constructed at Anzin, on the German principle of forcing air into the mass of small coal to be washed, so as to draw off the dust by current. 1100 w. Col Guard—July 16, 1897. No. 14255 A.

EXPLOSIVES.
Government Apparatus for Testing Explosives to be Used in Coal Mines. James Ashworth. Details of an apparatus erected at Woolwich, Eng., for a series of experiments, and a comparison of this apparatus with those which have been used in past experiments. 1800 w. Col Guard—July 23, 1897. No. 14362 A.

FIREDAMP.
Sudden Outbursts of Firedamp and Measures for Avoiding Accidents. A record of facts which are of a nature to throw light on these phenomena, obtained from records of engineers who have specially studied the subject. 4000 w. Col Guard—July 9, 1897. No. 14062 A.

HUNGARY.
See same title under Miscellany.

OUTPUT.
End of the Control of the Output Scheme. Editorial comment on the proposal of the associated coal owners of South Wales to limit the output in order to obtain better prices. 1300 w. Eng, Lond—June 25, 1897. No. 13849 A.

POWER Plant.
The Test of a Coal-Mining Electric Power Plant. T. D. Phillips and J. G. Swain. Gives a series of tests made upon the electrical equipment of Shaft No. 1 of the Brazil Block Coal Co. of Brazil, Ind. The machine gave good results and proved well adapted to the work required. Ill. 3000 w. Elec Wld—July 24, 1897. No. 14272.

SCREENING.
Screening Plant at Mossbeath Colliery. Walter H. Mungall. Read before the Mining Inst. of Scotland. Illustrated description. 1300 w. Col Guard—July 2, 1897. No. 13974 A.

SOUTH WALES.
The Coal and Iron Industries of South Wales. Details of the chief coal and iron industries. Part first deals largely with the coal trade. Information of the docks, the resources, output, characteristics, methods of working, winding, &c. Ill. 16500 w. Ir & Coal Trds Rev—July 23, 1897. Serial. 1st part. No. 14383 A.

STRIKE.
See same title under Economics and Industry, Labor.

VENTILATING Fans.
Experiments Upon Propeller Ventilating Fans and Upon the Electric Motor Driving Them. William George Walker. Read before the Inst. of Mech. Engs. Full account of experiments with results. 5400 w. Eng, Lond—June 25, 1897. No. 13850 A.

COPPER.

ARIZONA.
An Arizona Copper Deposit. John F. Blandy. Brief description of what the writer considers a deposit of great economic value. 600 w. Eng & Min Jour—July 24, 1897. No. 14235.

GOLD AND SILVER.

ARIZONA Mines.
The Mineral Resources of Arizona. Thomas Tonge. Considering the territory by counties. Ill. 4100 w. Eng Mag—Aug. 1897. No. 14407 B.

ASSAYING.
Assaying of Gold and Silver. Jacob B. Eckfeldt. Part first describes the assaying of gold, as conducted at the U. S. Mint in Philadelphia. 1600 w. Min & Sci Pr—July 3, 1897. Serial. 1st part. No. 13935.

AUSTRALIA.
West Australian Gold Mining. C. E. Moreing's paper read before the London Inst. of Civ. Engs. A summary of the principal features of the gold fields of this region. 1300 w. Min & Sci Pr—July 3, 1897. No. 13936.

CALIFORNIA.
Condition of Gold Mining in California. Charles G. Yale. The change in the character and system of mining, the production, and the value of other minerals mined in this State. 1300 w. Min & Sci Pr—July 10, 1897. No. 14017.

CHLORINATION.
Practical Workings of Chlorination. Thomas G. Taylor, Jr. Describes the process as carried on at the Champion Mine at Nevada City. 2560 w. Min & Sci Pr—July 17, 1897. No. 14223.

COMSTOCK Lode.
The Situation in the Comstock Deep Levels. Dan de Quille. Comment on the false impressions that seem to prevail regarding this mine,

and an outline of the work soon to be undertaken, with the hopeful outlook. 3000 w. Min & Sci Pr—July 10, 1897. No. 14016.

CYANID.

New Cyaniding Plants at Mercur, Utah. An account of two important new plants soon to be put up. 900 w. Eng & Min Jour—July 31, 1897. No. 14390.

Professor Christy on Cyanid. W. Bettel. A review of S. B. Christy's paper on "The Solution and Precipitation of the Cyanid of Gold." A severe criticism. 3800 w. Reprint from So African Min Jour—May 8, 1897. No. 14301 B.

DEPOSITS.

The Mineral Formation of the Golden Leaf Mines. Robert W. Barrell. Describes an unusual formation in southwestern Montana. 1600 w. Eng & Min Jour—July 17, 1897. No. 14039.

ELECTRO Deposition.

See same title under Electrical Engineering, Electro-Chemistry and Metallurgy.

GOLD Yield.

The Gold Yield of 1896. An American view claiming increase in production and great activity in gold-mining. 1400 w. Aust Min Stand—May 27, 1897. No. 13885 B.

GRAVEL Washing.

Gold Gravel Washing in Eastern Siberia. E. D. Levat. Illustrated description of the sluices in the placers worked by the Zeya Company. 900 w. Aust Min Stand—June 3, 1897. No. 13887 B.

KLONDIKE.

The Alaskan Gold Discoveries. Remarks on the effect of the recent discoveries both on the financial markets and speculation. Mention of the difficulties to be faced in reaching the region is made, and of the severe life due to the climate. 1000 w. Bradstreet's—July 31, 1897. No. 14386.

The Alaskan Placers. Brief account of the new discoveries, the routes by which to reach the Klondike fields, the mines so far discovered, and the dangers and hardships of the region. 1800 w. Min & Sci Pr—July 24, 1897. No. 14314.

The Gold Finds of Alaska. Words of caution regarding investments, with some information of the country, the deposits, and the products. 2500 w. West Min Wld—July 24, 1897. No. 14284.

The Klondike Gold Fields. Brief account of location, climatic conditions, ways of reaching the gold fields, method of mining, &c. 1000 w. Sci Am Sup—July 31, 1897. No. 14297.

The Yukon Gold Excitement. Presents facts leading to the belief that the Klondike is a very rich placer gold deposit, also giving information of the country, the climate, cost of transportation, and the attitude of the Canadian government. Short editorial also given. 1800 w. Eng & Min Jour—July 31, 1897. No. 14389.

LOW GRADE Ores.

The Concentration of Low Grade Ores. Edmund B. Kirby. Read before the International Gold Mining Convention. Reference is made to the various processes and their application to different grades of ore; the history of ore concentration and the improvements made it in are reviewed; the four different systems noticed, etc. Min Ind & Rev—July 15, 1897. Serial. 1st part. No. 14090.

MERCUR, Utah.

Gold Mining in Mercur, Utah. John Dern. Condensation of a paper read at the International Mining convention at Denver, Colo. The history of the camp, its failures and success made possible by the application of cyanide. 2000 w. Min & Sci Pr—July 24, 1897. No. 14313.

MEXICO.

Notes on Mining in Oaxaca, Mexico. Maurice Clark. Reports concerning the three mining districts of this state, and pronounces it one of the most favorable fields in Mexico. 2200 w. Eng & Min Jour—July 10, 1897. No. 13988.

PLACERS.

Placer Mining. Gives calculations made to estimate the plan of working a placer, and the value and future of the same, as an illustration of the correctness. 2200 w. Min Ind & Rev—July 8, 1897. No. 13996.

PRODUCTION.

The Production of Gold in the United States in 1896 and the Mint Reports. Explains the discrepancy between the figures as reported by this journal and those of the Director of the Mint. 1800 w. Eng & Min Jour—June 17, 1897. No. 13987.

SILVER Mine.

The North Star Silver Mine. An account of valuable property in British Columbia. Ill. 1300 w. Can Min Rev—July, 1897. No. 14379 B.

SLIMES.

The Reduction of Zinc-Gold Slimes. E. H. Johnson. Notes read at the annual meeting of the Chemical and Metallurgical Society of S. Africa, describing the writer's own methods. 1200 w. S African Min Jour—June 19, 1897. No. 14302 B.

SMELTING.

The Present Status of Pyritic Smelting. Herbert Lang. Explanation of the reasons for abandoning the process at Keswick, and a defense of the process. 2500 w. Eng & Min Jour—July 10, 1897. No. 13989.

TASMANIA.

The Lefroy Goldfields (Tas.) A. Montgomery. Describes the geology, deposits, &c., in part first. 3500 w. Aust Min Stand—June 10, 1897. Serial. 1st part. No. 14291 B.

VEINS.

Vein Walls. T. A. Rickard. Abridged from a paper read before the Am. Inst. of Min. Engs. Interesting illustrated description of some typical formations as shown in the mining fields of western America. 3800 w. Col Eng—July, 1897. Serial. 1st part. No. 13998 C.

IRON AND STEEL.

ALABAMA.

See same title under Coal and Coke.

BLAST Furnaces.

Blast Furnaces, July 1, 1897. Showing the condition of blast furnaces of the United States at this date. Tables. Am Mfr & Ir Wld—July 16, 1897. No. 14069.

COLONIAL Ironworks.

Colonial Ironworks in 1731 and Afterwards.

Historical account of the industry in this country in colonial times. 1500 w. Bul Am Ir & Steel Assn—July 20, 1897. No. 14224.

COOLING.

The Influence of Sudden Cooling on Nearly Pure Iron. J. O. Arnold. Criticises statements and experiments of H. Marion Howe, and report of experiments by the writer, with results. 1300 w. Engng—July 9, 1897. No. 14045 A.

IRON Mine.

An Unusual Piece of Mining Work. J. T. Donald. Describes the deposits and mining at Turtle Lake, on the Canadian Pacific Railway, and gives the method used to determine the quantity of ore. 1000 w. Eng & Min Jour—July 24, 1897. No. 14236.

IRON Trade.

See same title under Economics and Industry, Commerce and Trade.

MESABA Range.

Mining Methods on the Mesaba Range. C. E. Bailey. From a paper read at the Tower meeting of the Am. Inst. of Min. Engs. Describes the deposits, systems of operating, &c. 2500 w. Ir Age—July 29, 1897. No. 14342.

MICROSCOPE Accessories.

Microscope Accessories for Metallographers. John E. Stead. Read before the Iron and Steel Inst. Hints which will facilitate work in this field. Ill. 2500 w. Engng—June 25, 1897. No. 13852 A.

PRICES.

See same title under Economics and Industry, Commerce and Trade.

PRODUCTION.

American Iron and Steel. Editorial on the annual report of the iron and steel production just issued by the American Iron and Steel Association. 1400 w. Engng—July 23, 1897. No. 14368 A.

RUSSIA.

The Russian Iron Trade. Report showing that the industry is steadily developing. 900 w. Mach, Lond—July 15, 1897. No. 14281 A.

SOUTH WALES.

See same title under Coal and Coke.

STEEL Rail.

See same title under Railroad Affairs, Maintenance of Way.

STEEL Works.

The Illinois Steel Company. Illustrated description and leading facts connected with the works of this company, with a brief historical and statistical statement. 11500 w. Ir Age—July 15, 1897. No. 14003.

TENSILE Strength.

Tensile Strength of Steel. H. K. Landis. Discusses the influences that affect the strength of steel, and presents equations, the results of a large number of tests, comments on their discrepancies, &c. 2500 w. Am Mfr & Ir Wld—July 30, 1897. No. 14382.

TESTS.

Elasticity and Fatigue. H. K. Landis. The importance of quality in construction work is noted, elasticity and fatigue defined, the usual method of testing commercial steel examined, with suggestion. 1900 w. Am Mach—July 29, 1897. No. 14319.

Univalence of Transposed Tests. N. P. Gladis. Arguing that the most satisfactory method of investigation is to submit the piece to the specific kind of stress it is designed to resist in its legitimate service. 2500 w. Ag of St—July 10, 1897. No. 13991.

MINING.

BREATHING Apparatus.

An Apparatus for Breathing in Mines. Richard Cremer. Describes the pneumatophor, an invention to enable rescuers to enter immediately, without danger, those parts of a mine full of after-damp, and to enable a miner to save himself. Ill. 1400 w. Eng & Mining Jour—July 31, 1897. No. 14391.

CONGELATION.

Sinking with Congelation, at Anzin. M. Saclier and M. Waymel. From a communication to the Société de l'Industrie Minérale. Part first gives a description of the preparatory works and the congelation. Ill. 4000 w. Col Guard—July 23, 1897. Serial. 1st part. No. 14361 A.

ECONOMY.

Economy in Mining. G. C. Mitchell. Excerpt from presidential address to the members of the Mining Institute of Scotland. The necessity of attention to details and of making the most careful preliminary calculations in connection with colliery management. 3800 w. Can Min Rev—July, 1897. No. 14380 B.

HORSES.

Selection and Management of Mine Horses. M. Ernest Boissier. From a communication to the Société de l'Industrie Minérale. Calls attention to the requirements of the work and the points necessary, that the horse may work as long and economically as possible; the care needed, food, stabling, &c. 3500 w. Col Guard—June 25, 1897. No. 13835 A.

MACHINERY.

Applications of Electricity in Mines (Les Applications de Electricité dans les Mines.) With illustrations of hoists, ventilators, pumps, locomotives, &c. 2500 w. Revue Technique—June 25, 1897. No. 14137 D.

SALE of Mines.

Legal Decisions with Reference to the Sale of Mines. It is proposed, to supply information on this subject, to notify the doctrines pronounced in England in the cases heard and determined by the high and appeal courts, irrespective of the statute law relating thereto. Various cases are presented. 3200 w. Col Guard—July 2, 1897. No. 13973 A.

SHAFTS.

Plumbing Shafts. George B. Hadesty. A republished article, giving a reliable and simple method for carrying a meridian into a mine. 1600 w. Col Eng—July, 1897. No. 14001 C.

THE NORTHWEST.

Mining in the Northwest. Arthur Lakes. An interesting general account of the advances made in mineral discoveries during the past twenty years in a region not previously recognized as a valuable mineral bearing territory. 2200 w. Col Eng—July, 1897. No. 14002 C.

U. S MINING Law.

Law of Mines in the United States. A brief review of mining legislation. 3300 w. Col

Guard—July 9, 1897. Serial. 1st part. No. 14061 A.

TUNNELS.

Tunnels and Tunnel Sites. T. A. Rickard. Discusses the value of tunnels in mining, the recent decision of the Supreme Court in the Enterprise-Rico-Aspen tunnel case, and the writer's views on this subject. 1400 w. Eng & Min Jour—July 17, 1897. No. 14041.

UNDERGROUND Photography.

Underground Photography. James Underhill. Directions showing how with simple appliances, easily carried into a rough country, valuable photographs may be secured. Ill. 1100 w. Eng & Min Jour—July 31, 1897. No. 14388.

VENTILATION.

American Fan Ventilation for Mines. Illustrations, with details of some of the large centrifugal fans. 2000 w. Ir & Coal Trds Rev—July 2, 1897. No. 13925 A.

MISCELLANY.

ALASKA.

The Alaska Trip. John Muir. An interesting illustrated description of the beautiful scenery and particulars of the journey. 6800 w. Century Mag—Aug., 1897. No. 14372 D.

ARGENTINE REPUBLIC.

Mineral Resources of the Argentine Republic. James McKean Rowbotham. An abridged paper contributed to the Inst. of Civ. Engs. Reports great variety of mineral products, and some account of the mining and value. 1500 w. Col Guard—July 16, 1897. No. 14258 A.

CALORIMETRY.

The Calorimetric Determination of Heating Values of Combustibles. (Kalorimetrische Heizwertbestimmung.) L. C. Wolff. A very full investigation of the method by chemical analysis, compared with the calorimeter tests by Mahler-Stohmann, and Kröker, with carefully worked examples. A valuable paper. 6000 w. Zeitschr d ver deutscher Ing—July 3, 1897. No. 14106 B.

CORUNDUM.

Report on Some Trial Excavations for Corundum Near Palakod, Salem District, India. Information relating to the work, the geology, proportion of corundum in the rock, cost of operations, &c. Map. 2500 w. Ind Engng—June 26, 1897. No. 14315 D.

DEFORMATION.

The Permanent Deformations of Metals. (Sur les Déformations Permanentes des Métaux.) M. Faurie. The existing formulas are re-derived by a new method of investigation, using chains with links composed of different metals. 1200 w Comptes Rendus—June 28, 1897. No. 14130 D.

FIRE Precautions.

See same title under Architecture and Building, Construction and Design.

HUNGARY.

Mines and Metallurgy in Hungary. Antoine Kerpely. Condensed translation from an article in the catalogue of the Section Hongroise, Brussels Exposition, giving information of the mining industry, working and quantity of coal. 1100 w. Col Guard—July 16, 1897. Serial. 1st part. No. 14257 A.

MINING Industry.

Mechanical and Engineering Progress as Influenced by the Mining Industry. John Birkinbine. Calls attention to some of the achievements due to the mineral resources, and their influence on the progress of the country. 3000 w. Jour Fr Inst—July, 1897. No. 13884 D.

NITROGLYCERINE.

Nobel and his work. (L'Oeuvre de Nobel.) Louis Roux. A biographical notice of Nobel with a review of the development of modern high explosives. 2500 w. Revue Technique—July 10, 1897. No. 14143 D.

ORE Deposits.

The Mine Hill Ore Deposits in New Jersey and the Wetherill Concentrating Plant. J. P. Wetherill. History of the working of the ores of Sussex County, New Jersey, with description of plant, and account of suits against the company. Ill. 3000 w. Eng & Min Jour—July 17, 1897. Serial. 1st part. No. 14040.

PETROLEUM Wells.

Petroleum Wells in the Suburbs of Los Angeles, California. Illustration with brief account of the disfiguring of a pretty suburb by the needlessly numerous and unsightly oil derricks, with some information of the yield and value. 1100 w. Sci Am—July 17, 1897. No. 14012.

PRECIOUS Stones.

Precious Stones and Recent Science. F. G. S. in *Mining World*. Notes giving some idea of the value of recent researches. 1800 w. Aust Min Stand—June 3, 1897. No. 13886 B.

TIN.

The Malay Tin Industry. T. Flower Ellis. A paper read at a recent meeting of the Chemical and Metallurgical Society of South Africa. Describes these very rich deposits, and the methods of mining and extracting the tin. Ind and East Eng—June 12, 1897. Serial. 1st part. No. 14037 D.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACCOUNTS.

Paris Gas Accounts. Report of income, expenditure, capacity, &c. 1500 w. Gas Wld—July 3, 1897. No. 13953 A.

ACETYLENE.

Illumination of Niagara Falls. Illustrated description of the lighting by acetylene gas. 700 w. W Elec—July 24, 1897. No. 14288.

Recent Research on Acetylene. G. E. Brown. Abstract of three papers by H. G. Söderbaum on his experiments with acetylene. 1100 w. Pro Age—July 15, 1897. No. 14007.

The History, Status, and Possibilities of Acetylene. Henry Harrison Suplee. Showing that greater economy of production is alone needed to make acetylene a competitor of gas. 4400 w. Eng Mag—Aug., 1897. No. 14409 B.

The Patent Side of Acetylene Gas. Information from a circular bearing on the patents owned by the Electro Gas Company of New York. 3200 w. Pro Age—July 15, 1897. No. 14008.

ANNUAL Congress

Société Technique du Gaz en France. Abstract translations of technical papers read at this meeting. Description of the Kudlicz grate of a hinged scoop, and paper on retort-houses. Ill. 1800 w. Jour Gas Lgt—July 13, 1897. No. 14228 A.

BENZOL.

Benzol as an Illuminating Agent. (Das Benzol und seine Bedentung als Leuchtstoff.) Giving comparative results with other illuminants, both photometrically and commercially. Especially good results are obtained by usinga mixture of alcohol and benzol to heat an incandescent mantle. 2500 w. Gesundheits Ingenieur—June 30, 1897. No. 14167 B.

The Recovery of Benzol from Coke-Oven Gases. Particulars on benzol recovery obtained chiefly from a paper by Dr. C. Heinzerling. 1500 w. Jour Gas Lgt—June 29, 1897. No. 13918 A.

BURNER.

The Improved Denayrouze Burner. States the improvements as explained at meeting of the Société Technique du Gaz en France. 900 w. Jour Gas Lgt—July 6, 1897. No. 14067 A.

BY-PRODUCTS.

By-Products and Adjuncts of the Gas Industry. H. Bunte. From the proceedings of the annual meeting of the German Gas and Water Engineers at Berlin. Remarks on the mutual relation of these products from the economical and commercial point of view. 1100 w. Am Mfr & Ir Wld—July 9, 1897. No. 13980.

FURNACES.

Furnace Jottings. Maurice Graham. From *Journal of Trade Journals*, Birmingham, England. On the system of inclined retorts, and the successful working of a furnace. 2300 w. Am Gas Lgt Jour—July 26, 1897. No. 14278.

GASHOLDER.

The Middlesborough Gasholder. Mr. Henry Woodall's report upon the accident that befell the rope-guided gasholder in February last. Facts of the case with the opinion of the writer. 2200 w. Gas Wld—July 10, 1897. No. 14066 A.

JUBILEE Illuminations.

Gas at the Jubilee Illuminations. Describes some of the devices used. 2500 w. Jour Gas Lgt—June 29, 1897. No. 13919 A.

OIL Gas.

Some Notes on an English Oil Gas Process. F. Egner. Describes R. W. Herring's method as used at the Corporation Gas Works, Huddersfield, Eng. 1600 w. Am Gas Lgt Jour—July 5, 1897. No. 13840.

WATER-GAS Plant.

Carburetted Water-Gas Plant at Saltley Gas Works, Birmingham. Illustrated description of the plant and the process of manufacture. 1600 w. Engng—July 23, 1897. No. 14366 A.

SEWERAGE.

SEWAGE.

Sewage Disposal by Artificial Filtration. G. Reid. Read at meeting of Assn. of Municipal and County Engineers, England. Describes the Garfield Coal Filter and reports favorably regarding its efficiency. 2500 w. Builder—July 3, 1897. No. 13977 A.

Sewage Irrigation. Geeorge W. Rafter. Contains many details and gives a discussion of sewage purification in the United States, with descriptions of the works at various localities. Ill. 36500 w. U. S. Dept of the Interior—1897. No. 14341 D.

The Essex Fells Sewage Filter. Illustrated description of a simple and effective method of purifying a daily flow of about 20000 gallons, by distributing it over the surface of natural beds of gravel in which drains are laid to carry the inoffensive effluent into an adjacent brook. 700 w. Eng Rec—July 3, 1897. No. 13880.

The Problem of Sewage Disposal. Charles Francis. Read at the convention of the American Water Works Assn. The two systems considered worthy of discussion are the broad irrigation or sewage farming system, and intermittent downward filtration. 3700 w. Fire & Water—July 31, 1897. No. 14373.

The Sedimentation Process in Sewage Disposal. Arthur N. Talbot. Describes this method, recommending it where an inexpensive method is essential, and as a preliminary process. Discussion follows. 3500 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14206 D.

The Septic Tank System of Sewage Treatment. Donald Cameron. Portion of a paper read before the Devon and Exeter Architectural Society. Explains the system and its advantages. 1900 w. Builder—July 10, 1897. No. 14065 A.

The Sewage Filter Beds of Altoona, Pa. Information regarding the intermittent filtration adopted, and the construction of the filter beds. Ill. 2300 w. Eng News—July 22, 1897. No. 14237.

SEWER Ventilation.

Sewer Ventilation and Its Bearings upon Public Health. Edward Walford. From report submitted to Health Committee. Gives the results of investigations at different points. Thinks when sewers are well constructed and thoroughly flushed, the ventilation is a matter of minor importance. 2200 w. San Rec—July 23, 1897. Serial. 1st part. No. 14398 A.

STREETS AND PAVEMENTS.

BRICK Pavement.

A Country Road Paved with Brick. J. Ed. Miller. Describes a brick road made with crushed stone curbing. Discussion. 2000 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14207 D.

Expansion of Brick Pavements in Hot Weather. Reports from Niagara Falls, Cleveland and other places regarding the upheaval of pavement, and the supposed causes. 500 w. Eng Rec—July 17, 1897. No. 14053.

How to Lay Brick Pavements. J. R. Haldeman. A brief article giving directions. 1000 w. Clay Rec—July 14, 1897. No. 14216.

Report of Committee on Paving Brick Specifications and Tests. The qualifications for durability are stated as toughness and hardness,

imperviability to liquids, and strength. Report was followed by discussion. 5000 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14208 D.

STREET Cleaning.

Asphalt and Wood-Paving in Relation to Street Cleaning. Notes on the necessity of keeping asphalt clean, and the merits of these two kinds of pavement. Asphalt is considered the best of all pavements when properly cared for. 800 w. San Rec—July 16, 1897. No. 14263 A.

The Street Washing Plant at Oldenburg. (Wasserleitung zur Spülung von Srassengossen in Oldenburg.) Fr. Noack. Describing the special system of mains and hydrants for flushing and washing the streets. 2000 w. Gesundheits Ingenieur—July 15, 1897. No. 14169 B.

WATER SUPPLY.

BAVARIA.

The Water Supply of the Kingdom of Bavaria. (Die Wasserversorgung im Königreich Bayern.) An abstract from the official reports giving a general review of the work of the bureau from its establishment in 1878, to 1896. 2500 w. Gesundheits Ingenieur—June 15, 1897. No. 14164 B.

CONDUITS.

Repair Details of the Rochester, N. Y., Water-Works. Conduits in 1896. Information from report of Emil Kuichling, chief engineer, in regard to the repairs and condition of both old and new conduits. 2000 w. Eng Rec—July 24, 1897. No. 14275.

FAUCETS.

Intermittent Faucets. (Fontaine Intermittente.) The Giraud system feeds two vessels alternately from the main, and the water can only be drawn alternately by reverse operations of one lever, hence it is impossible to leave the faucet running continually. 2000 w. Revue Technique—June 25, 1897. No. 14138 D.

FILTRATION.

Water Filtration. Churchill Hungerford. An explanation of why properly constructed filter beds improve with age. Ill. 1000 w. Sci Am—July 31, 1897. No. 14294.

IRON Removal.

Removal of Iron from Ground Waters. Harry W. Clark. A report on the efforts to remove iron from the water supply of Provincetown. About 98% was removed by the use of coke. Discussion follows. 2800 w. Jour N Eng Water Works Assn—June, 1897. No. 13859 F.

The Iron-Removal Plant at Reading, Mass. Lewis M. Bancroft. Describes plant, gives Mr. Desmond FitzGerald's report and recommendations for removing the iron, also the plan adopted and the results. Ill. 1800 w. Jour N Eng Water Works Assn—June, 1897. No. 13861 F.

The Water Supply of Provincetown, Mass. Louis E. Hawes. A description of the source of supply with observations and remarks concerning the iron in the water. Also discussion. 4200 w. Jour N Eng Water Works Assn—June, 1897. No. 13860 F.

MAGDEBURG.

The Question of the Magdeburg Water Supply. (Die Wasserversorgungsfrage der Stadt Magdeburg.) Discussing the pollution of the water supply of the city of Magdeburg, and the possible methods of purification. 3500 w. Gesundheits Ingenieur—June 30, 1897. No. 14166 B.

MEASURING Evaporations.

An Apparatus for Measuring Evaporations in Freezing Weather. Describes methods used by Mr. Emil Kuichling at the Mt. Hope reservoir of Rochester, N. Y. 700 w. Eng Rec—July 31, 1897. No. 14414.

ORGANISMS.

Raphidomonas. George C. Whipple. Describes the trouble caused by a new infusorian. 3000 w. Jour N Eng Water Works Assn—June, 1897. No. 13865 F.

POTSDAM.

The Waterworks of Potsdam. (Die Entwässerung Potsdams.) With brief account of the filtering and clarifying plant. Aug. Kroitzsch. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—July 16, 1897. No. 14120 B.

PUMPING.

Pumping Machinery. Abstract of a paper by Charles A. Hague, read before the Denver meeting of the American Water Works Assn. The importance of adapting pumping machinery more closely to the work it is to do. 2000 w. Eng Rec—July 3, 1897. No. 13881.

Test of High Duty Pumping Plant Under Ordinary Working Conditions. Dabney H. Maury, Jr. Reports the test of the plant of the Peoria, Ill., Water Company, made under ordinary working conditions. Describes plant, apparatus and tests, giving results. Ill. 8000 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14205 D.

RESERVOIRS.

The Failure of the Melzingah Dams of the Fishkill and Matteawan Water Co. Illustrated study of the accident. 3000 w. Eng News—July 22, 1897. No. 14243.

Two Reservoirs Burst. Illustrated description of the bursting of the Melzingah reservoirs, 500 feet up the Fishkill mountains. 600 w. Fire & Water, July 17, 1897. No. 14078.

SAND Filter.

Covered Sand Filter at Ashland, Wis. William Wheeler. A statement of the conditions, description of filter, cost, cleaning and care, operation. Followed by discussion. Ill. 10000 w. Jour N Eng Water Works Assn—June, 1897. No. 13862 F.

SANITARY Biology.

Microscopical Examination of Water, with a Description of a Simple Form of Apparatus. George C. Whipple. The importance of the study, the methods that have been employed, and description of apparatus. 2400 w. Science—July 16, 1897. No. 14027.

WATER Mains.

The Method of Laying Small Sized Water Mains; of Lowering Mains; and the Relief of Violent Fluctuations on the Direct Pressure System at Madison, Wis. John B. Heim. Paper read at convention of the Am. Water Works Assn., at Denver, Colo. Discusses the

methods employed and the results obtained. 2500 w. Fire and Water—July 24, 1897. No. 14229.

Testing Water Pipe Distribution Systems. F. L. Fuller. Describes the manner of testing pipe systems used by the writer with very satisfactory results. Discussion follows. Ill. 3000 w. Jour N Eng Water Works Assn—June, 1897. No. 13863 F.

WATERSHEDS.

A Form of Mass Diagram for Studying Yield of Watersheds. Theodore Horton. Describes a graphical solution of these problems, and the construction of the diagram. 2400 w. Eng Rec—July 31, 1897. No. 14413.

MISCELLANY.

MUNICIPAL Lighting.

See same title under Electrical Engineering, Lighting.

STABLES.

Sanitary Stables and Farm Buildings. Louis Hanks. Suggestions on drainage and other important matters. 2800 w. San Rec—July 16, 1897. No. 14264 A.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

JUNGFRAU.

The Plant of the Jungfrau Railroad. (Die Kraftaniagen, Leitunzen und Fahrzeuge der Jungfraubahn.) E. Strub. An account of the power plant and general scheme of the electrically operated rack railway now being constructed to the summit of the Jungfrau; with illustrations of the electric locomotive. 4000 w. Schweizerische Bauzeitung—July 17, 1897. No. 14149 B.

SURVEYING.

Preliminary Work in Railway Construction. (Ueber Eisenbahn-Vorarbeiten.) A paper before the German Railway Society by Dr. Jordan, of Hannover, particularly discussing the surveying and topographical work preliminary to the actual construction of road bed. 6000 w. Glaser's Annalen—July 15, 1897. No. 14159 D.

MAINTENANCE OF EQUIPMENT.

BRAKES.

Railway Safety Brakes. W. G. Creamer. An account of the circumstances that led to the invention of the Creamer safety brake, the difficulties encountered, &c. Ill. 2000 w. Ry Mag—June, 1897. No. 13934 C.

CAR Ventilation.

The Ventilation of Passenger Cars on Railroads. Charles B. Dudley. Showing the difficulties to be overcome in this problem, and a general study of the subject, with tests and experiments. Ill. 7000 w. Jour Fr Inst—July, 1897. No. 13883 D.

CAST IRON Wheels.

Specifications and Guarantee for Cast Iron Wheels. Report of committee appointed by the M. C. B. Assn. to revise the specifications and guarantee for cast iron wheels, and to consider the form of wheel. 3400 w. Ry Rev—July 3, 1897. No. 13903.

GRATES.

Locomotive Grates for Anthracite Coal. From the report of the committee of the Am. Ry. Master Mechs. Assn. Discusses water tubes, tubes with filling pieces, tubes with shaker fingers, shaking grates, and transverse shaking grates. 2800 w. R R Gaz—July 23, 1897. No. 14246.

Ratio of Grate Area, Heating Area and Cylinder Volume. From the report of the committee of the American Railway Master Mechanics' Assn. The proper ratio for freight and passenger engines. The plan followed is stated, with deductions and calculations. Diagrams. 2200 w. R R Gaz—July 9, 1897. No. 13958.

HEATING Apparatus.

Heating Apparatus, Belgian Grand Central Railway. E. Belleroche. From a paper published in the Bulletin of the International Railway Congress. Describes the system of heating passenger trains on this road, which consists essentially of circulating hot water along the train and back again, from the engine. 1500 w. Am Eng & R R Jour—Aug., 1897. No. 14323 C.

LOCOMOTIVES.

Brooks-Monon Eight-Wheel Express Locomotive. Drawings and specifications of two engines recently delivered to the Chicago, Indianapolis and Louisville Railway. 1200 w. Ry Rev—July 17, 1897. No. 14093.

Heavy Locomotives for the Southern Railway. Gives summary of the principal dimensions of 10-wheel passenger locomotives. 1400 w. R R Gaz—July 23, 1897. No. 14247.

Locomotives for the Soudan. Dimensions and details of construction of the essential parts, with illustration. 800 w. Ry Rev—July 24, 1897. No. 14287.

The Balanced Locomotive. Report of tests at Purdue University of a locomotive without driving wheel counterbalance. Ill. 3500 w. Ry Age—July 30, 1897. No. 14378.

The Latest Great Northern Single-Wheeler. Charles Rous-Marten. Describes a greatly improved engine, the departures from the usual practice being due to H. A. Ivatt, locomotive superintendent of the Great Northern Ry. Ill. 2000 w. Eng, Lond—June 25, 1897. No. 13847 A.

The Latest Heilmann Electric Locomotive. Illustrated description of the new locomotive, with brief recapitulation of the leading features of the designer's first engines, and the reasons for so radical a departure. 1700 w. Ry Wld—July, 1897. No. 14072 A.

ROLLING Stock.

Railway Rolling Stock at Berlin, Budapest, and Nürnberg, 1896. (Die Eisenbahn-Fahrbetriebsmittel zu Berlin, Budapest, und Nürnberg, 1896.) H. v. Littrow. Describing and illustrating the railway carriages at the recent expositions, giving the latest forms of continental cars—two articles, four plates. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—July 9 & 16, 1897. No. 14118 E.

VALVES

Improved Arrangement of Reducing and Intercepting Valves—Rogers Compound Locomotives. Illustrated description of the latest form as applied to five compound locomotives now in service in Jamaica and four in Chili. 700 w. R R Gaz—July 23, 1897. No. 14244.

MAINTENANCE OF WAY.

BRIDGE Renewing.

Bridge Renewing on the C. B. & Q. Illustrated description of the method of replacing iron through truss bridges with plate girders. 1000 w. Ry Rev—July 31, 1897. No. 14417.

COLUMBIA Bridge.

Rebuilding of the Pennsylvania Railroad Bridge at Columbia, Pa. Brief historical account of the various bridges built at this point and the disasters to the structures. 700 w. Ry Rev—July 17, 1897. No. 14095.

GIRDER Bridge.

See same title under Civil Engineering, Bridges.

RAILS.

Continuous Rails. Editorial discussion of the relation existing between a rail and a continuous beam or girder, and the advantages to be derived from the adoption of continuous rails. 1800 w. Eng, Lond—July 9, 1897. No. 14059 A.

STATION Lighting.

The Lighting of Isolated Railroad Stations. Describes and illustrates a connected system of oil lighting, in use on the New York, New Haven & Hartford Railroad. 1600 w. Am Eng & R R Jour—Aug., 1897. No. 14322 C.

STEEL Rail.

The Growth and Development of the Steel Rail in America. H. G. Prout. Reviewing the history of the steel rail since 1887. Ill. 5600 w. Eng Mag—Aug., 1897. No. 14402 B.

SWING Bridge.

Railway Swing Bridge Over the River Nene. Illustrated detailed description of a bridge recently opened for traffic at Sutton Bridge, on the Midland Great Northern Railway, England. 2000 w. Eng, Lond—July 23, 1897. No. 14394 A.

TIES.

Railway Ties in India. Clement F. Street. Describes some of the designs now in use on the railways of British India, in which country metal ties have probably been more extensively used than in any other. Ill. 10500 w. Jour W Soc of Engs—June, 1897. No. 14303 D.

TILE Protection.

The Protected Railway Depot and Viaducts. Illustrated description of the improvements of the Illinois Central Railroad Company, at Van Buren and Harrison streets, in Chicago. Overhead crossing bridges, and suburban passenger station, in which fireproof tiling has been used to veneer the whole surface of the metal-work. 1800 w. Eng Rec—July 31, 1897. No. 14412.

WAY Maintenance.

Methods and Standards of Maintenance of Way. W. M. Duane. Extracts from a paper read before the St. Louis Railway Club, May 14, 1897. Discusses sub-grade, curves, ballast, rail sections, joints, &c. 1700 w. Ry Rev—July 3, 1897. No. 13904.

SIGNALING.

THOMAS System.

The Thomas Pneumatic System of Handling Railway Switches and Signals. Part first is an illustrated description of the switch arrangements of this system. 1400 w. Ry Rev—July 17, 1897. Serial. 1st part. No. 14094.

TERMINALS AND YARDS.

BOSTON Southern.

Engineering Equipment of the Boston Southern Terminal Station. An account of an unusually comprehensive and complete engineering equipment intrusted to one firm of contractors—Westinghouse, Church, Kerr & Co. 1000 w. Eng News—July 8, 1897. No. 13945.

TRANSPORTATION.

ACCIDENTS.

Railway Accidents in 1896. Review of the Board of Trade returns in England and comments on the new form in which the tables are cast. 1200 w. Engng—July 2, 1897. No. 13967 A.

Train Accidents in the United States in May, 1897. A classified statement and summary. 2000 w. R R Gaz—July 16, 1897. No. 14035.

CAR Handling.

Handling of Foreign Cars. W. E. Beecham. From the report to the Central and Western Car Service Assn. Gives recommended practice. 2500 w. Ry Age—July 2, 1897. No. 13875.

EARNINGS.

Less Pronounced Railway Earnings' Increases. Report with tables of comparison, showing gross earnings for June, and for the past six months. 1800 w. Bradstreet's—June 10, 1897. No. 13944.

EXCURSIONS.

The Christian Endeavor Excursions. An account of the handling of heavy traffic on the roads west of the Mississippi, which has broken all previous records of the excursion business moving by sleeping cars. 1800 w. R R Gaz—July 9, 1897. No. 13959.

The Movement of the Excursion over the Southern Pacific. Details of how the Christian Endeavor excursion was handled. 600 w. R R Gaz—July 16, 1897. No. 14031.

FAST Runs.

Remarkably Fast Time. Report of a notable record made by the Lehigh Valley R. R. Co.'s Black Diamond express. 350 w. Col Eng—July, 1897. No. 14000 C.

GREAT BRITAIN.

Passenger Service and Rates in Great Britain. W. M. Acworth. Report of new cars and various improvements recently introduced on the different roads, with reduction in rates and changes in third-class travel. 1100 w. R R Gaz—July 16, 1897. No. 14030.

HOT Boxes.

Hot Boxes—Their Causes. M. P. Cook. From a paper presented at the May meeting of the St. Louis Railway Club. Reviews the conditions that cause hot boxes, the injury, and the writer's opinion as to the best way of cooling.

2500 w. R R Gaz—July 16, 1897. No. 14034.

INTERCHANGE.

The Rules of Interchange. Discussion of the M. C. B. Code of interchange rules at the recent convention of the Master Car Builders' Assn., with editorial. 17000 w. R R Car Jour—July, 1897. No. 13978.

OPERATING Expenses.

The Operating Expenses of Minor Railways. (Ueber Betriebs Kosten von Bahnen, Insbesondere Solcher Niederer Ordnung.) E. Rindl. A methodical investigation into the details of the operating expenses of the German tramways, and minor local roads, with formulas and diagrams. Two plates, 12000 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—June, 1897. No. 14162 D.

POOLING.

Pooling Railroad Earnings. J. A. Latcha. Claiming that the safety of the people of the United States requires the pooling of the wealth and power of the railroads under state supervision. 1500 w. N Am Rev—Aug., 1897. No. 14422 D.

RATES.

Rate Reductions in Kansas. E. P. Ripley. A protest from the president of the Santa Fé against the proposed reductions in grain rates, with editorial. 3300 w. Ry Age—July 2, 1897. No. 13874.

Rate Reductions in Kansas. W. H. Truesdale. The protest of the Rock Island road against the commission's proposed cuts. 2700 w. Ry Age—July 16, 1897. No. 14051.

TELEPHONE Dispatching.

See same title under Electrical Engineering. Telegraphy and Telephony.

TICKETS.

Interchangeable Mileage Tickets. Describes the new tickets for use of commercial travelers, with editorial comment. 2000 w. Ry Age—July 30, 1897. No. 14377.

TROPICS.

Difficulties of Transportation in the Tropics. C. P. Yeatman. Picturing the workings of competition between the locomotive and the mule. Ill. 4100 w. Eng Mag—Aug., 1897. No. 14401 B.

MISCELLANY.

ECONOMY.

Wasteful Economy. Editorial discussion as to whether the tendency toward heavier track, more powerful locomotives, and larger cars, has not reached its practical limit. 700 w. Ry Rev—July 31, 1897. No. 14418.

What Is True and False Economy in Light Railway Construction. A brief discussion of some of the requirements and of conditions that should regulate expenditure. 1000 w. Mach, Lond—July 15, 1897. No. 14282 A.

ELECTRIC Railroading.

The Status of Electric Railroading. Reviews editorially the progress in the substitution of electricity for steam, and the conditions to be met ere the advancement can satisfy those interested in railroad working. 2500 w. R R Gaz—July 9, 1897. No. 13960.

EMPLOYES.

The Physical Examination of Employés. Henry F. Hoyt. Read before the tenth annual convention of the International Association of Railway Surgeons. An argument for a physical examination of all employés, with editorial. 3000 w. Ry Age—July 9, 1897. No. 13981.

FIGHTING Snow.

Fighting Snow on the Railroads of the Northwest. Description received from E. W. Hadley, of Santa Barbara, Cal., with illustrations. 3000 w. Sci Am—July 10, 1897. No. 13906.

FLOODS.

Floods Along the Southern Railway. B. C. Milner, Jr. Illustrated account of the damage, which was much less than anticipated. 1600 w. R R Gaz—July 16, 1897. No. 14036.

HAULAGE.

Electric Haulage at Port Chalmette. G. F. P. Account of the adoption of electricity in the place of compressed air, and claiming greater economy. Also editorial objecting to conclusions and defending compressed air. 2000 w. R R Gaz—July 9, 1897. No. 13957.

INDIA.

Indian Railway Property. Reviews the conditions of these railways, and the effect of the famine. 1500 w. Engng—June 25, 1897. No. 13853 A.

Indian Railway Questions. Discusses mail service, connection with docks, conditions of recent working, the Bombay Baroda line, and the loss caused by the famine. 1800 w. Trans—June 25, 1897. No. 13873 A.

Some More Facts About Indian Railways. Information from the Administration Report on the Railways of India for the year 1896-97 prepared by the director-general of railways. Also table showing the position of all the principal railways as regards net earnings, and the percentage of net earnings to capital expenditure in the past two years. 1400 w. Trans—July 16, 1897. No. 14279 A.

JAPAN.

Railways in Japan. Report on the progress of railways, prepared by Mr. Lowther for the Foreign Office. 1800 w. Arch, Lond—July 23, 1897. No. 14371 A.

LOADING.

A Study of Load Equivalents. (Beitrag zur Lehre von den Belastungs-Aequivalenzen.) Franz Podhajsky. A graphical and analytical investigation into the manner in which the distribution of loads upon beams and girders takes place with various combinations of locomotives and cars. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—June 11, & 18, 1897. No. 14113 E.

LEGISLATION.

Railroad Legislation in Connecticut. Reviews the 16 acts passed during the present year. 800 w. R R Gaz—July 16, 1897. No. 14033.

NARROW Gauge.

Comparative Study of the Standard and the Metre Gauge. (Etude Comparative entre la Voie Normale et la Voie de 1 Metre.) J. Martin. A revival of the narrow gauge discussion, with especial reference to conditions in France. Serial. 4 parts. 18000 w. Revue Technique—May 25, June 10 & 25, July 10, 1897. No. 14141 J.

RAILROADING.
Knotty Points of Railroading. Discusses the railway conditions in the United States, and the many problems needing to be faced. Considers that both construction and competition have been overdone. 2200 w. Trans—July 23, 1897. No. 14358 A.

RAILWAYS.
Light Railways. Lists of applications granted and new schemes under consideration, with editorial comment on the effect in England of the Light Railways Act, motive power, &c. 1500 w. Ry Wld—July, 1897. No. 14075 A.

SOUTH AFRICA.
South African Railways. F. W. Wilson. An interesting account of the peculiar features of the South African railway systems, with description and matters related. 4700 w. Eng News—July 15, 1897. No. 14021.

VIBRATIONS.
See same title under Civil Engineering, Miscellany.

WATER Supply.
Water Supply for Locomotives. Thomas Appleton. From a paper read before the Western Railway Club. Discusses the quality, location of tanks, methods of supplying tanks, &c. 1200 w. R R Gaz—July 16, 1897. No. 14032.

STREET AND ELECTRIC RAILWAYS.

ACCIDENTS.
Report on the Liverpool Overhead Railway Accident. A reprint of the report of H. A. Yorke to the Railway Dept. of the Board of Trade on the accident of April 15, 1897. Gives description, evidence and conclusion. 3500 w. Elect'n—July 9, 1897. No. 14084 A.

APPARATUS.
The Thomson-Houston Magnetic Blow-Out, as Applied to Electrical Traction Apparatus. Part first considers controllers and wiring apparatus in which the magnetic blow-out is applied, showing that in the design both efficiency and wearing qualities have been studied. Ill. 1700 w. Ry Wld—July, 1897. No. 14076 A.

BERLIN.
Recent Railway Improvements in Northern Berlin. (Neuere Eisenbahnaulagen im Norden Berlins.) A very full paper by Herr Bathmann describing important underground and overhead work, with numerous illustrations and 4 plates. An important and valuable railroad paper. 15000 w. Glaser's Annalen—June 15, 1897. No. 14157 D.

BOSTON Elevated.
Estimated Cost of the Boston Elevated. Estimates of the sums necessary to go ahead with the work, as presented by George A. Kimball, engineer of the company. 700 w. R R Gaz—July 30, 1897. No. 14350.

BUENOS AYRES.
The Street Railway System of Buenos Ayres. Illustrated account of the system, which has until recently been operated by horses. Electric lines are being rapidly constructed. 1700 w. St Ry Jour—July, 1897. No. 13854 D.

ELECTRIC Railroading.
See same title under Railroad Affairs, Miscellany.

The Present Status of the Electric Railroad. F. B. H. Paine. A reply to opinions expressed in this paper, and giving the writer's views. Thinks that electricity is not yet adapted for the moving of heavy trains for long distances, but thinks there are indications of a gradual change. Also editorial. 3700 w. R R Gaz—July 30, 1897. No. 14349.

ELECTRIC Traction.
Electric Traction. Review of a book by Philip Dawson, which gives particulars of all the various systems. 2300 w. Builder—July 24, 1897. No. 14419 A.

The Deri Combined Alternating and Continuous-Current System for Electric Tramways. Description of an ingenious system, with editorial presenting its advantages and disadvantages. 3000 w. Elect'n—July 2, 1897. No. 13963 A.

FLYWHEEL Explosion.
See same title under Mechanical Engineering, Power and Transmission.

GAS Traction.
The Gas Railroad. Frederick Egner. An account of recent observations in the line of gas traction, showing that ordinary illuminating gas can be used to furnish economical means of propulsion for street railways. Ill. 1500 w. Am Gas Lgt Jour—July 12, 1897. Serial. 1st part. No. 13993.

HAULAGE.
See same title under Railroad Affairs, Miscellany.

Tramway Haulage. E. J. Silcock. Read at the annual meeting of the Incorporated Assn. of Municipal and County Engs. Part first begins the discussion of the relative merits and demerits of the various systems, briefly reviewing horse and steam traction, oil, gas and compressed air. 2400 w. Ind & Ir—July 23, 1897. Serial. 1st part. No. 14357 A.

INCLINE Railway.
Incline Railway Up Mt. Tom. Illustrated description of the road and equipment. 900 w. St Ry Rev—July 15, 1897. No. 14096 C.

INSULATION and Resistance.
Methods of Testing the Insulation and Resistance of Street Railway Lines. Frank B. Porter. Describes some of the tests usually employed by street railway electricians for determining the resistance of the insulation and the resistance of the conducting circuits of their lines. Ill. 2200 w. Elec Wld—July 17, 1897. No. 14024.

LOOP.
The Chicago Union Elevated Loop. A description, with plan, of the most complicated elevated railroad problem which has yet arisen. 2200 w. Ry Age—July 23, 1897. No. 14267.

MOTORS.
Electric Railway Motors. George T. Hanchett. Part first illustrates and describes forms of field magnets. 2000 w. St Ry Jour—July, 1897. No. 13857 D.

General Electric Company's New Street Railway Motor. Illustrated description. 900 w. Elec Rev—July 14, 1897. No. 14006.

OPERATING Expenses.

See same title under Railroad Affairs, Transportation.

POWER Plant.

Chicago City Railway Company's New Electric Power Plant. Illustrated description of interior of plant. 1400 w. W Elec—July 17, 1897. No. 14048.

POWER Transmission.

The Efficient Transmission of Power to Street Railway Lines. R. W. Conant. The subject is limited to the medium voltage, direct current transmission. The solution of a few special cases is given, to illustrate a method used by the writer. 2500 w. St Ry Rev—July 15, 1897. No. 14097 C.

REPAIR Shops.

Some Remarks on Street Railway Repair Shop Management. Frank B. Porter. Considers a few methods which have been adopted by some systems, and found to effect a saving. 2500 w. St Ry Rev—July 15, 1897. No. 14201 C.

The Repair Shops of the Brooklyn Heights Railroad Company. Illustrated detailed description. 2700 w. St Ry Jour—July, 1897. No. 13855 D.

SPEEDS.

Investigations on the Speed of Trains on the Berlin Local Railway. (Versuche ueber die Fahrgeschwindikeit der Berliner Stadtbahnzüge.) Giving the construction of the ingenious speed indicator used, with diagrams plotted by its aid. 1 plate. 4000 w. Glaser's Annalen—July 15, 1897. No. 14160 D.

STOPPAGE Losses.

Loss in Stoppages of Electric Cars. Hermann S. Herring. Reply to a query on this subject, giving the results of tests, and advising the using of brakes as little as possible and drifting as much as possible. 1500 w. Am Elect'n—July, 1897. No. 13897.

STREET Railway Bridges.

Some Street Railway Bridges. Illustrations and descriptions of some designs for street railway traffic. 1500 w. St Ry Rev—July 15, 1897. No. 14098 C.

TRACTION.

Electric Traction. M. H. Gerry, Jr. A brief discussion of some of the more important problems in the application of electric motive power to the heavier classes of railway service, with illustrations from the practice of the Metropolitan Elevated Road of Chicago. 5700 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14213 D.

TRAMWAYS.

Country Roads vs. Small Electric Tramways. (Sollen wir Land Strassen oder Elektrische Kleinbahnen Bauen?) Describing a system of very narrow gauge electric railways, with trucks upon which ordinary wagons can be carried. 1200 w. Deutsche Zeitschr f Elektrotechnik—June 15, 1897. No. 14178 B.

Tramway Extension in Smaller Towns and City Suburbs. Discusses the obstacles to the extension of tramways in England. 1600 w. Ry Wld—July, 1897. No. 14073 A.

The Birmingham Tramway Report. Extract from report submitted by the sub committee on the systems of various European cities. Ill. 2500 w. St Ry Rev—July 15, 1897. No. 14200 C.

TROLLEY System.

Extension of the Underground Trolley System in New York. An outline of work undertaken on the Eighth and Fourth Avenue lines. Ill. 900 w. Sci Am—July 31, 1897. No. 14295.

Overhead Trolley System for Multiphase Motor Roads. (Oberirdische Stromzuführung für Drehstrombahnen.) An arrangement by which two overhead metallic conductors are used, giving details of double conductor trolley pole, etc. 2000 w. Deutsche Zeitschr f Elektrotechnik—June 15, 1897. No. 14180 B.

The Trolley Is Free. Full text of the decision of the U. S. Circuit Court of Appeals in the case of the Thomson-Houston Electric Company vs. the Hoosick Railway Company. 4400 w. Elec—July 28, 1897. No. 14312.

WIRE.

Tension and Bending Strength of Electric Trolley Wire. (Zug-und Biegungs Festigkeit der Draht-Materialen für Elektrische Bahnen.) Giving a table of tests of various steel and copper wires. 1000 w. Deutsche Zeitschr f Elektrotechnik—June 15, 1897. No. 14181 B.

BOOKS OF THE MONTH

Howe, Malverd A., A Treatise on Arches. Designed for the Use of Engineers and Students in Technical Schools. John Wiley and Sons, New York. Chapman & Hall, London. 1897. Cloth, $4.

An octavo volume of 371 pages, containing 73 illustrations, may seem to to the lay reader a large amount of space to devote to the almost exclusively mathematical discussion of a single element of construction. The professional reader, who readily comprehends all that is involved in the design of arches to meet special conditions of load distribution, and in the use of different materials for arch construction, will see that compactness is not necessarily sacrificed in a book of this size, and that thorough treatment of the subject is impossible within certain limits. The aim of the author appears to have been to simplify existing formulas derived from Weyruch's four fundamental equations of the elastic arch, and to present a series of general formulas which in their integral form are applicable to "any symmetrical arch, either fixed or hinged, and subjected to either vertical or horizontal loads . . . when the equation of the axis and the law of variation of the moments of inertia of the cross sections are known." The usually neglected effect of the axial stress is discussed, and formulas for all practical cases likely to occur are given. Formulas for vertical and horizontal loads, and for special cases of changes of temperature and shape, are also presented. In the treatment of the subject of masonry arches, "the many difficulties and inaccuracies of the common methods of treatment" are pointed out, and it is shown that a masonry arch may be so designed that "its stresses will follow the laws demonstrated for the elastic arch." In designing segmental masonry arches, the author adopts Alexander and Thompson's method "as being the most consistent of the many methods which assume all loading due to material to act as vertical forces upon the arch." One of the most important and valuable chapters in the book for the practising engineer is Chapter II, which contains "a collection of all the necessary formulas likely to be needed in practice," in such a simplified form that they can with the aid of tables be applied with ease and celerity. The author expresses the belief that "a fair trial of the summation formulas in this chapter will lead to the adoption of metal arches more artistic in form than the usual American type. The book is well printed, and bound in the usual style of college text-books.

Hopkins, Thomas C., M. S, M. A. Assistant Professor in the Pennsylvania State College. The Building Materials of Pennsylvania. I. Brownstones. Appendix to the Annual Report of Pennsylvania State College, for 1896. Paper.

Contains 125 pages (octavo) of text, 26 full page plates, and two maps showing location of quarries. A great deal of valuable information is presented. The author is an expert on the subject of building stones, having published several monographs on the subject in the government and different State geological survey reports and numerous shorter articles in the scientific and trade journals. Pennsylvania is one of the leading states in the production of brownstone, and is surpassed by none in the quality of the stone produced and the number of quarries. The report is divided into three parts, the first treating of the general features of brownstones, the second describing in detail the different quarries and quarry regions of the State, and the third part describing briefly the competitive quarries in other States. The first part discusses thoroughly the chemical composition of brownstones, giving a great many analyses from different quarries, and the signification of the different elements are pointed out. The structural, textural, and mineralogical features are fully described and illustrated by means of photographs and pen drawings. The durability of brownstones is discussed

at some length, and an explanation is offered for the crumbling of the brownstone in this and other eastern cities. Crushing absorption and fire tests of a great many different brownstones are given. The methods of quarrying and handling the stone, and the uses and adaptability of the different varieties are given with its distribution in the State, illustrated by a map showing the location of each quarry.

American Street Railway Investments (Red Book Supplement to the *Street Railway Journal*). New York, Chicago, and London. 1897. Cloth, $3.

In addition to the well-known special features of this publication, by which it holds a distinctive place among books of its class, are a "Review of the Year," in which is a brief exposition of the chief events bearing on street railway affairs that have occurred during the last year in the principal cities of the country, and a table of "gross receipts in 1895 and 1896" showing the percentage increase or decrease in receipts for every system whose gross receipts exceed $25,000. The information contained in this table is of much value, particularly as the companies are arranged according to magnitude of operations in 1896, so that each company can easily find out what others of its class are doing. The work also contains much information of local interest embodied in tabular form, and in the text.

The regular contents of the book include the tabular presentation of gross receipts, operating expenses, and balance sheets for from three to five years, by means of which a company's complete financial statements may be examined for surreptitious concealment of expenses or profits; the "dates of information," which are appended to each report; and the authenticity of the information, as shown by the statement that, out of 1,262 companies in existence in the United States and Canada, more than 80 per cent. have sent in "approved" reports from proof sheets sent to them before publication, while nearly all the remainder have been brought up to date from official sources of information. An unusual number of carefully-prepared and finely-engraved maps of street-railway properties is found in the "Red Book" and adds much to its value. The arrangement of indexes and their completeness is an excellent feature.

Among 1,262 corporations named, 939 are operating, 206 are operating under lease, and 117 are not yet in operation.

Wallace, Robert, F. L. S., F. C. S., F. R. S. Farming Industries of Cape Colony. P. S. King & Son, London. 1896. Cloth. 10s. 6d.

Possessing a rare educational equipment for the performance of such a task, Professor Wallace has in this treatise written one of the most interesting of contemporaneous books. To those seeking information about the climate, soil, and resources of southern Africa the work will be as valuable as it is interesting to the general reader. Eighty-one full-page plates, fourteen maps, six plans and ninety-two illustrations assist the text in the graphic representation of the peculiar features and agricultural resources of a truly remarkable country. Professor Wallace visited Cape Colony at the invitation of its government. While sojourning in the land, he was afforded ample facilities for a study of conditions under which farming must be carried on, the kinds of implements and machinery adapted to the needs of the colonial farmers, and the probable commerce which the agricultural interests of the colony have created and will create. The text embodies the results of a laborious four months' tour, in which copious notes were taken. Mr. Wallace is an acknowledged expert, being professor of agriculture in the University of Edinburgh, and it is seldom that so much of general and scientific interest is compressed in a book of this size devoted to agricultural research. The work contains 552 octavo pages, and is well indexed.

Mead, Elwood, State Engineer. Third Biennial Report of the State Engineer to the Governor of Wyoming. 1895 and 1896. The S. A. Bristol Co., Cheyenne, Wyoming. 1897. Cloth.

Mr. Mead, in this report, deals exclusively with the subject of irrigation and irrigation works, which are the most important public works in the State of Wyoming. The report is a valuable contribution to the growing literature of irriga-

tion, a subject that is constantly assuming greater importance in connection with the reclamation of the arid western lands of the United States. The report shows that a little more than one thousand water rights have been adjudicated in Wyoming since the previous biennial report was issued. Mr. Mead says that "the total volume of water thus dedicated to beneficial uses" is more than 3,394 cubic feet per second, and that water rights have, by formal certificates of appropriation, become attached to more than ninety thousand acres of land. The water is obtained for this purpose from sixty streams and two springs. The most important topics treated are "Water Rights" (pages 37 to 62) and the "Needs of Irrigation" (pages 158 to 167 inclusive). Under the latter heading are discussed the necessity for subsidies to important canals. The position is taken that, if we are to reclaim our best land and use our large rivers for this purpose, State aid in building reservoirs and large canals is imperative. The report then shows that free grants of water, and the speculative control of streams, which have formed part of the policy of other arid regions, put a perpetual mortgage on every irrigated home so supplied. There is much in this report to awaken thought, and direct public attention toward a sound policy in the reclamation of western lands, now deserts, but capable of being made exceedingly fertile and productive.

Fuertes, James H. Water and Public Health. The Relative Purity of Water from Different Sources. John Wiley & Sons, New York. Cloth, $1.50.

The principal cities of the world are herein grouped with reference to the quality of their water-supply, as a basis of a comparative study of mortality statistics. Thus the importance of pure water is placed in a stronger light than it can be by the data of more widely scattered observations. It is thought, also, that by the adoption of this method the admitted inaccuracies in the statistics presented in reports of physicians, health boards, etc., assumed as being about equally in the nature of excess and deficiency, will counterbalance each other, and the final result so attained will contain very little error. The statistics of typhoid fever in American cities have been compiled from municipal reports, reports of State boards of health, and correspondence. Four chapters precede the appendixes, which contain the compilation of data. Chapter I discusses the etiology and prophylaxis of typhoid fever; chapter II answers the question: "When does pure water pay?"; chapter III treats of the sanitary value of impounded water; and chapter IV summarizes conclusions derived from the data compiled. Appendix A gives statistics of death-rates from typhoid fever per 100,000 of population in various cities for the years 1890–1895 inclusive. Appendix B contains descriptions of the sources of water-supply of various cities. Appendix C gives the annual rain-fall as observed at some fifty cities of the United States. Appendix D contains a table showing the number of times that different typhoid-fever death-rates per 100,000 occurred in all the cities named in appendix A, during the six consecutive years beginning with 1890. Diagrammatical representations of death-rates are also presented. The book supplies in a very convenient form for comparison and reference a mass of data not otherwise obtainable without an expenditure of time which most engineers would gladly avoid.

IMPROVED MACHINERY

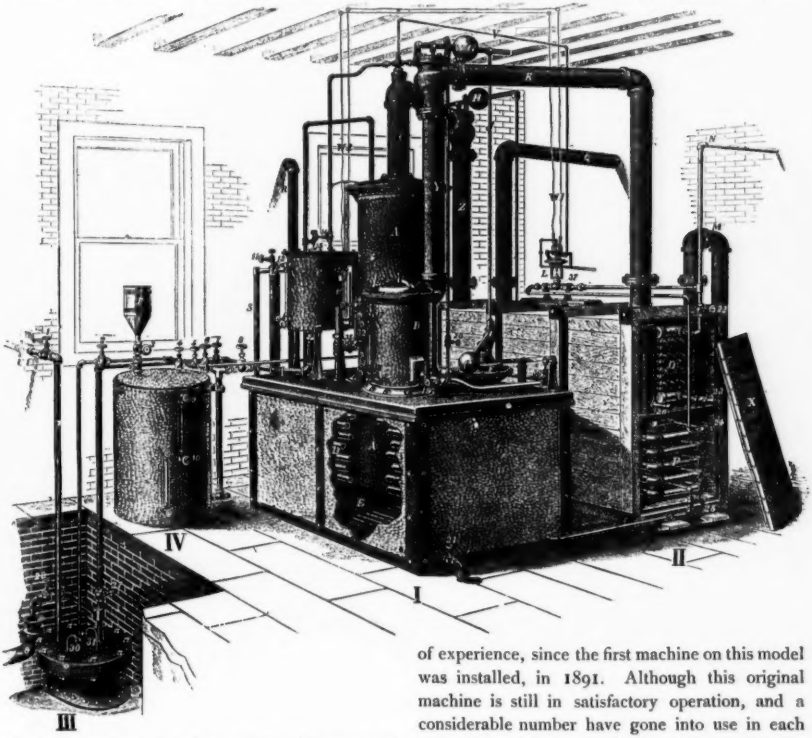
NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The "New" American Oil Gas Machine.

THIS machine is designed for the generation of a pure hydrocarbon gas from naphtha, for use as fuel. The system is based upon the belief that it no longer accords with scientific progress to use coal in a crude state, and that every consideration of economy requires the separation of crude fuel into its component parts before the performance of its final function. It is the object of the system to convert the total of a given amount of refined petroleum into gas, which is then converted into heat without waste by draft or consumption in unused space. There is produced a practically fixed gas consisting of dry air charged with atomized oil. No gas-holder is required, but gas is discharged directly into the main pipe under a constantly even pressure.

The system is not new, properly speaking, but attention is called to what the manufacturers designate as the "New" American Oil Gas Machine, illustrated in an accompanying engraving. It embodies every improvement suggested by six years of experience, since the first machine on this model was installed, in 1891. Although this original machine is still in satisfactory operation, and a considerable number have gone into use in each year since, with the approbation of the purchasers, the manufacturers are now able to offer for the first time what they themselves can approve of as a complete piece of work in this line.



The gas machine proper (Fig I) contains the generator, A; the feeding tank, B, which regulates the supply of oil to the generator; the water pressure regulator, C; the circulating pipe, D, an

elongated coil through which the oil flows to be warmed after passing through the generator unconverted; the radiator, E, for raising the temperature of the oil circulating in the machine.

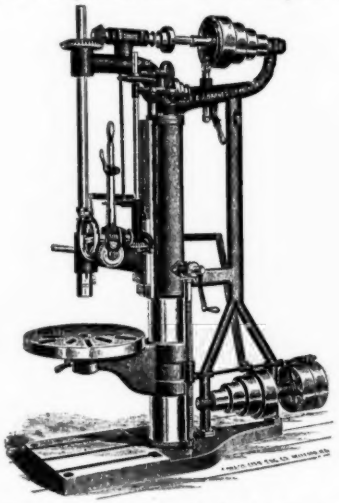
Fig. II. shows the heating chest provided with steam for heating the air supply before it enters the generator, and the gas after it leaves the generator. It has two compartments: P, for air as it comes through the blower, and O, the chamber for heating the gas, received by the pipe Y and discharged to the storage tank by the pipe M. Fig. III is the storage tank for oil. It shows the head of a reservoir of 8,000 gallons capacity, four feet under ground, projecting into the gas house under an arch or beam. All connections pass through a thick manhole cover. Figure IV is the measuring tank used to ascertain the consumption of oil, by reference to gage glasses.

This machine forms part of a patented system embracing (1) a fuel gas generator; (2) a blower for the regulation of pressure in the generator and at the points of consumption; and (3) the furnace in which the heat of the gaseous fuel is utilized. The system is used by leading manufacturers of bicycle material, watches and machinery, and by assayers and refiners of bullion, and others who desire an efficient, perfectly controllable, and economical system of generating and utilizing fuel gas.

The manufacturers, The American Gas Furnaces Co., 23 John St., New York, not only use the gas produced by this system in their furnaces, but also in the production of power in their works, at Elizabeth, N. J., and also for lighting the factory. They are prepared to supply inquirers with information as to the comparative cost of their gas and other forms of fuel, and also as to its merits in other respects.

New Sliding Head Back-Geared Drill.

THIS drill has been designed and placed on the market by the W. F. & John Barnes Company, Rockford, Ill., U. S. A., in response to an inquiry for a smaller drill than the 28-inch drill manufactured by the same company, and also to meet all the requirements for a drill intermediate in size and capacity between their 25-inch stationary head drill and their 28-inch and 34-inch sliding head drills. The new machine—illustrated herewith—has been designed with special care, and is believed to embody all features essential to a complete and perfect tool. The workmanship is first-class. The feed arrangement is especially strong, and provides for all the different feeds which can be used on a drill press. The cut shows very clearly the feed mechanism. The drill has power self-feed with automatic stop, lever and worm feed, and quick return for spindle. The feature of hand lever feed on a sliding head drill in combination with worm and power feed is new and increases the usefulness of the drill. Every movement of the drill is designed for the convenience of the operator, who has at his disposal five



different feeds; a lever feed, hand worm feed, self power feed, automatic stop, and quick return. The back-gear is claimed to be the neatest and cleanest back-gear on the market; it is of internal movement and free from dirt, and gives the best of satisfaction.

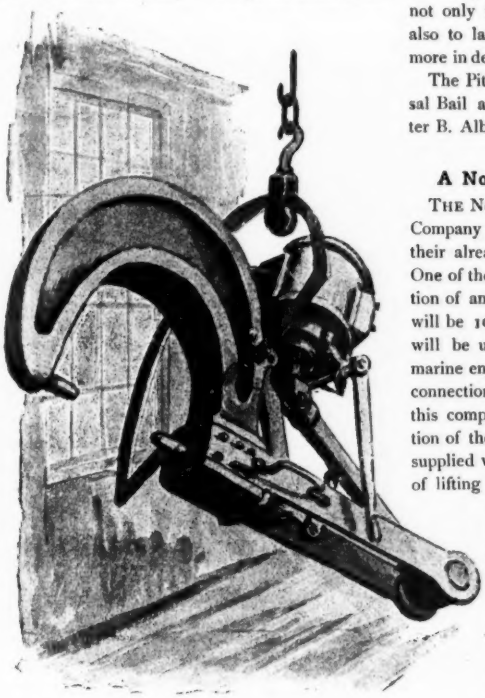
The spindle is fitted with the No. 3 Morse taper.

The Pittsburg Riveter and the Albree Universal Bail.

THE development of pneumatic machinery during the last ten years is one of the most marked features of mechanical advancement. The invention of special machinery, to accomplish work hitherto done by hand or by more cumbersome machines, is keeping pace with invention in other new fields. Among the latest adaptations of compressed air power, is the Pittsburg Riveting machine.

It consists of a simple trunk piston cylinder—which exerts its force on a revolving lever carrying a hardened steel roller on its lower end, the upper end having a fixed center. The roller travels on the upper surface of a hardened steel roller bar—fixed at one end and attached to a plunger—

moving in guides at the other end. In this plunger is a screw, carrying a riveting die, which, by the movement of the roller on the roller bar, is caused to move vertically. The power is increased



by leverage of the toggle-joint type, so that at the end of the stroke the pressure is practically immeasurable. The cut illustrates the latest type of this riveting machine. This latest form has a new and tested device, shown clearly in the cut, which adapts the machine to a variety of work that was not possible heretofore, except by means of cumbersome worm geared appliances.

The device consists of a semi circular bail—pivotted on trunnions, whose axis passes through the absolute center of gravity of the machine. The trunnion is suspended from a grooved roller, held in a swivelled fork. Being suspended from its center of gravity, the machine is held in perfect equilibrium. It follows that, in whatever position the riveter is turned, the grooved roller will always be over the true center of gravity, and that the machine can be held in any position in any plane, and yet perform its work as well as if it were in the ordinary vertical position.

The engraving shows the machine in a very peculiar position, and those using such machines can readily understand how useful this attachment would be for riveting crooked work, field work, circular pieces, etc. The Universal Bail is applied not only to small machines, such as shown, but also to large machines with throats five feet or more in depth.

The Pittsburg Riveter and the Albree Universal Bail are patented and manufactered by Chester B. Albree, Allegheny, Pa.

A Notable Contract for Steelwork.

THE Newport News Shipbuilding & Dry Dock Company are making extensive additions to their already large plant at Newport News, Va. One of the large additions under way is the erection of an extension to their machine shop, which will be 100' wide and 200' long. This building will be used for the finishing and erecting of marine engines and other large machinery used in connection with the mammoth steel vessels which this company has under way. The central portion of the building will be 50' high, and will be supplied with an electric travelling crane capable of lifting and carrying a load of 50 tons. On either side of this central space will be located a gallery arranged for small machines and fitting tools. The building is to have a steel framework throughout, and the roof is to be covered with corrugated iron. The Berlin Iron Bridge Company, of East Berlin, Conn., have the contract for furnishing and erecting the steelwork of the building.

NEW CATALOGUES.

Archer Iron Works, Chicago, Ill., U. S. A.=A neatly illustrated folder showing the different forms of steel wheel-barrows manufactured by this company. Steel barrows for handling all kinds of material are included.

Michigan College of Mines, Houghton, Mich.=Preliminary announcement for 1897–1898.

General Electric Company, Schenectady, N. Y., U. S. A.=Fifth annual report, 1897.

The Dayton Globe Iron Works, Dayton, Ohio, U. S. A.=(*a*) Elegantly printed, illustrated pamphlet, describing the "New American turbine with tables of hydraulic data, and details of wheels and setting, flumes, etc., etc (*b*) Pamphlet setting forth advantages, points of superiority, etc., of the "New American" turbine.

Garvin Machine Company, New York.=Pamphlet containing beautiful half-tone interior of the company's new building and its fine and complete equipment.

American Institute.=Press Bulletin American Institute Fair to be held Sept. 20, to Nov. 4th, at Madison Square Garden, N. Y. Allen S. Williams, Madison Square Garden, New York City, Chief of Press Bureau.

Boston Belting Company, Boston, New York, and Buffalo, U. S. A.=Card, describing advantages of Phoenix flange and joint packing.

Joseph Dixon Crucible Company, Jersey City, N. J., U. S. A.=Pamphlet, entitled "The Merits of Lead Paints and Dixon's Silica-Graphite Paint Compared."

R. D. Wood & Co., Philadelphia, Pa.=Elegantly printed and illustrated catalogue of hydraulic tools, cranes, and machinery.

The Link-Belt Engineering Company, Nicetown, Philadelphia, Pa.=Pamphlet entitled "Modern Methods," photographically reduced from large standard pamphlet size to small pocket size. Contains full, illustrated description of the link-belt system and its details.

James Leffel & Company, Springfield, Ohio, U. S. A.=New illustrated pamphlet describing horizontal and vertical throttling and automatic engines and portable and stationary boilers manufactured by this company.

New Jersey Car Spring & Rubber Company, Jersey City, N. J., U. S. A.=Illustrated descriptive catalogue of vulcanized rubber goods, including belting, packing, tubing, gaskets, valves, hose, etc., etc.

The Westinghouse Machine Company, Pittsburg, Pa.=Illustrated descriptive catalogue of Westinghouse gas-engines, setting forth their applications and advantages.

Lehigh University.=In view of misleading reports about the future of this institution which have been admitted to the columns of the daily press, the students, alumni, and friends of Lehigh University have united in a denial that it is in such a crippled condition as has been industriously represented. The partial failure of the ordinary revenues of the University has been followed by a liberal grant from the State, which will enable the college work to proceed without interruption. There is such a sentiment in favor of upholding this institution, manifested in the representative daily papers of Philadelphia and other large towns in Pennsylvania and throughout the State, and the action of the legislature in granting relief has been so generally approved, as to give assurance of a permanent future to this once promising seat of learning.

Harrison Safety Boiler Works, Philadelphia, Pa., U. S. A.=Illustrated pamphlet entitled "Additional Evidence of the Merits and Value of the Cochrane Separators." Describes the Cochrane separator and its operation, and gives a list of about a thousand users of this separator. A few pages are devoted to the Cochrane feed-water heater.

Toledo Machine Tool Company, Toledo, Ohio, U. S. A.=Catalogue and price-list for 1897, illustrating and describing a line of punching presses, drop presses, dies, and special machinery for working bar and sheet metals.

Clayton Air Compressor Works, New York.=Catalogue No. 9. Claimed to be the most complete catalogue of air compressors and compressed-air appliances ever attempted. It contains not only a description of the Clayton type of air compressors, with illustrations and lists of sizes and standard patterns, but also a descriptive article entitled "The Widening Use of Compressed Air," an explanation of the Clayton air-lift pumping system, and data for figuring the loss of pressure due to friction in transmitting compressed air through pipes, and in operating compressors at different altitudes above the sea.

Buffalo Forge Company, Buffalo, N. Y., U. S. A.="A," '97 Pocket edition catalogue of four hundred pages, being the pocket edition of the library bound book published in December last. A large edition of this very neat and compact publication has been printed, principally for engineers, and will be sent gratuitously upon application. As much matter is compressed into this little book, by the use of very small, but very clear, type, as is often contained in large octavo. It is unique among trade publications.

Cincinnati Corrugating Company, Piqua, Ohio, U. S. A.=Catalogue for 1897, illustrating and describing corrugated and galvanized building materials manufactured by this company, which claims to have been the first corrugating company in America.

The Westinghouse Air Brake Company, Pittsburg, Pa., U. S, A.=Pamphlet entitled "The Westinghouse High-Speed Brake." Illustrating and describing a distinct advance in the air-brake art.

Boston Motor Company, Boston, Mass.=Catalogue of experimental electrical supplies.

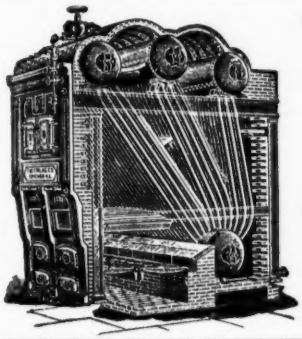
Randolph & Clowes, Waterbury, Conn., U. S. A.= Pamphlet, entitled "Touching a Tubular Triumph; The Due Reward of Nineteen Years of Seamless Tube Drawing.=Sets forth progress in the art, and illustrates and describes the achievements in copper tube drawing accomplished at their works, with an illustrated description of the special tube drawing machine employed by this firm in the manufacture of large-sized seamless drawn copper tubes.

Newburgh Ice Machine & Engine Company, Newburgh, N. Y, U. S. A.=Illustrated descriptive catalogue of ammonia ice machines, Whitehill-Corliss engines, etc., etc.

W. A. Hartt, Los Angeles, Cal., U. S. A.= Pamphlet, illustrating and describing Hartt's gravity elevator and tramway combined.

The Wais & Roos Punch and Shear Company, Cincinnati, Ohio, U. S. A.=Catalogue illustrating and describing a line of punches and shears, with price lists.

Dodge Manufacturing Company Mishawaka, Indiana, U. S. A.= *a*) Large handsome catalogue of power transmissions appliances, including wood split pulleys, appliances for rope transmission, etc., and a copy of the decision of Judge Sage, sustaining the Dodge and Philion patent, No. 200,402. (*b*) Chronological statement of actions, injunctions, etc.,—Dodge and Philion patent No, 200,462. (*d*) Circulars relating to the recent decision of Judge Sage, and the litigation which it terminated.



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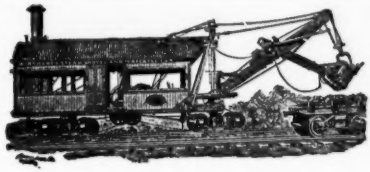

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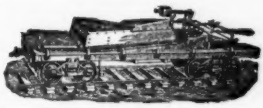

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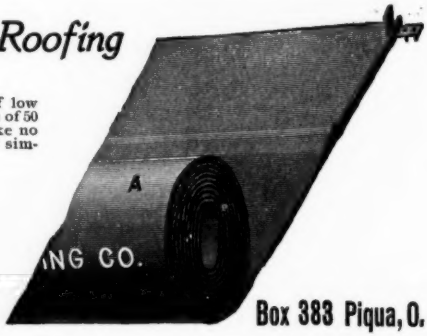

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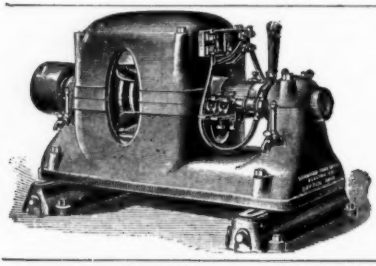

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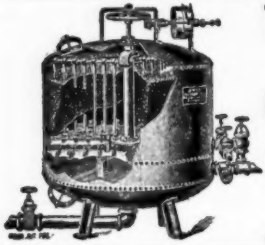

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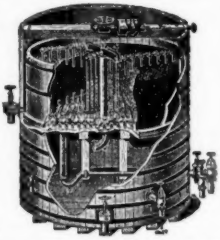

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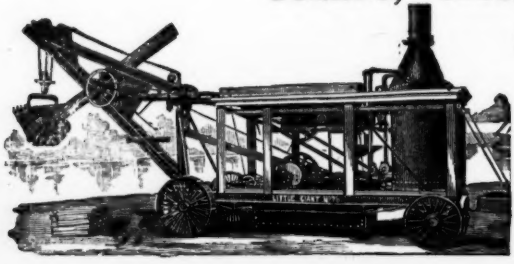

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THE ENGINEERING MAGAZINE,

{ Cable address: Palnud, New York.

120-122 Liberty St., New York, U. S. A.

AUTHORS AND PAPERS FOR SEPTEMBER.

J. STEPHEN JEANS (*Lessons of the Great Engineering Strike in England*)=For many years secretary of the British Iron Trade Association, and editor of the *Engineering Review* (London); was for a long time secretary of the British Iron and Steel Institute, and in that capacity visited the United States in 1890. He visited the Chicago exhibition in June, 1893, as the special commissioner of the British Iron Trade Association, and afterwards read a paper before that body on "The Chicago Exhibition, and its Lessons to the British Iron Industry." He is the author of numerous scientific and economic works and pamphlets, a contributor to the principal English magazines, and a fellow of several learned Societies in Great Britain. At present is editor and chief owner of *The Iron and Coal Trades Review*, London.

HENRY HARRISON SUPLEE (*Strength and Failure of Masonry Arches,*=Born October 23, 1856, at Philadelphia, Pa; graduated from the University of Pennsylvania in 1876, in the department of mechanical engineering; acquired practical experience in the mechanical establishment of his father the late Nathan R. Suplee; draftsman and designer for the firm of London, Berry & Orton, woodworking machinery, of Philadelphia, for a number of years; 1887 to 1890 editor of *Mechanics;* afterwards for five years with the Yale & Towne Mfg. Co., of Stamford, Conn.; at present consulting engineer and scientific expert in Philadelphia. Mr. Suplee has translated and published Reuleaux's "Constructor," and has also been a frequent contributor to the technical press. He is an active member of the American Society of Mechanical Engineers, and of the Franklin Institute, and has an extensive technical acquaintance and correspondence with foreign scientific men.

HORACE V. WINCHELL (*Soft Ore Mining by the Methods of the Minnesota Iron Company*)=Born in Michigan in 1865; graduated at the University of Michigan in 1889; Assistant State Geologist Minnesota, 1889–1891; in charge of explorations for Minnesota Iron Company, 1892–93; since 1893 has been engaged in practice of his profession as economic geologist and mining expert—office and laboratory at Minneapolis, Minn.; during past two years chiefly engaged in gold mining regions of the West; author of numerous brochures on ore deposits; joint author with Prof. N. H. Winchell of "The Iron Ores of Minnesota"; Fellow Am. Assoc. Adv. Sci; Fellow Geol. Soc. Am.; Member Am. Inst. Min. Eng., N. of Engl. Inst. Min. and Mech. Eng., Inter. Cong. Geol., etc.; corresponding editor for *Zeitschrift für praktische Geologie*, of Berlin.

PERCIVAL ROBERT MOSES (*Isolated Plants versus Central Stations*)=Born in New York; educated abroad and in U. S.; entered School of Mines, Columbia College, 1891; graduated in 1895–1896, with degree of electrical engineer; with Sprague Elevator Company in factory and construction work, 1896 to date; consulting engineer; associate member of the American Institute of Electrical Engineers.

LIEUTENANT RIDGELY HUNT, U. S. N. (*Fifty Years' Advance in Marine Engineering*)=Graduated from Annapolis in 1875; his father was Judge Hunt, Secy. of the Navy under Pres. Garfield and afterwards Minister to Russia; Lieut. Hunt's last shore duty was in the Office of Naval Intelligence, where he contributed to the Annual issued by that department; on his last cruise, Lieut. Hunt was secretary and aid to Admiral Gherardi during the naval review of 1893; he is now stationed at the Hydrographic Office, Maritime Exchange, this city.

AUTHORS AND PAPERS FOR SEPTEMBER.

J. PARKE CHANNING (*Mine Accounts*)=Born in New York City 1863; graduated at Columbia School of Mines in 1883; soon after went to Houghton, Michigan, with S. E. Cleaves & Son, manufacturers of mining machinery; afterward with the Tamarack, and Osceola mines as assistant mining engineer; was appointed deputy commissioner of mineral statistics, and wrote that part of the State report for 1884 covering the copper mines; spent a year in Honduras for Michigan capitalists, establishing steamboat navigation on the Ulua River and examining places and mineral lands; returned to Michigan in practice of general engineering, and in 1887 was appointed Inspector of Mines for Gogebic Co., holding that place till 1890; was superintendent of the East New York Iron Mine, and later in charge of the development company in Michigan of the Chicago, Milwaukee and St. Paul Ry.; resigned to accept a position with the Calumet and Hecla Mining Co., as assistant manager; since 1894 has been located at 34 Park place, New York City, as consulting engineer. It was at his suggestion, in 1885, that the Michigan Mining School was established. His proposal led to the founding of the Lake Superior Mining Institute, of which he was president in 1895. He has been an occasional contributor to the technical press.

E. T. ADAMS (*Economical Power Production in Small Units* =Received a varied technical training, working his way up from the workman's bench; early training in public schools at Hyde Park, Ill.; after a number of years work, chiefly in mechanical lines, received a university education at Stanford and at Cornell; his experience as stationary engineer entitles him to speak with authority on the status of this occupation; was instructor in charge of the department of drawing in city schools of Stockton, Cal.; instructor in mechanical drawing and descriptive geometry at Stanford University; graduate Cornell Unive sity, M. E., 1894; employed as designer by a prominent firm of engine builders; and at present instructor in department of machine design, Cornell University. Has contributed more or less to technical and other papers for several years past.

HAROLD B. GOODRICH (*The Gold Fields of Klondike and the Yukon Valley*)=Born in Hartford, Conn., in 1870; graduated A. B., Harvard, 1892; was employed as Assistant Geologist on the U. S. Geological Survey from 1894 to July, 1897; visited the Yukon River Gold Fields in Summer of 1896 as one of the members of the U. S. Geological Survey party.

W. WORBY BEAUMONT (*The Present Status of the Horseless Carriage Industry*)=Born 1848; apprenticed 1864 to the Reading Iron Works Co., steam engine, machine and agricultural implement makers, where he was engaged in construction of Lenoir gas-engines; he had previously for several years spent all the time school-hours would permit in small foundry and machine works belonging to his father; in 1867, went as improver to Ransomes, Sims & Jefferies, Ipswich, under his grandfather William Worby, (inventor of first portable steam thrasher, the self-moving steam-plough anchor, etc.), where he was engaged in erecting steam-engines and machinery; in 1872, became assistant and afterwards chief assistant to late Robert Mallet, F.R.S., civil engineer engaged on mechanical-engineering branches of civil-engineering work; subsequently was engaged in varied civil and mechanical-engineering and expert work, and afterwards was for over ten years joint editor of *The Engineer*, a position which he resigned early in 1896 in consequence of growth of his private practice in mechanical and engineering work, which he had carried on several years; has devoted much time to oil and gas-engine construction and testing, and latterly turned his attention to mechanically-propelled vehicles, in which his early experience with traction engines has been of value; is the inventor of the Vibromotor, now extensively used in all kinds of screening machinery, the antinertia variable-speed gear, tea machinery, and steam generators. His varied experience causes his frequent occupation as expert in patent and engineering litigation; is a member and gold medallist of the Institution of Civil Engineers, member of the Institution of Mechanical Engineers, Fellow of the Geological Society, and numerous other societies, and author of numerous papers in their proceedings.

FREDERICK HART SHELTON (*The Extending Use of Gas in Mechanical Operations*)=Born in Derby, Conn.; leaving College, Towne Scientific School, University of Penn., at the end of Freshman year, took up the profession of gas engineer; for twelve years in the service of the United Gas Improvement Company, actively occupied in the designing, construction and operation of various gas plants; has also been particularly identified with the development of the Lowe water gas process, which is now used for the manufacture of the greater portion of the illuminating gas made in the United States; in 1896 assumed the management of the Welsbach Light Company's interest in Chicago and the west; at present occupied in the field of incandescent gas lighting, at 67 Washington Street, Chicago; has published "Water Gas in the United States, Past and Present," "A Consideration of the Arguments For and Against Water Gas," "Gas Engines in the United States," and other articles in gas trade journals, and papers read before the American Gas Light Association, the Western Gas Association, the New England Association of Gas Engineers, and the Ohio Gas Light Association, of each of which he is a member.

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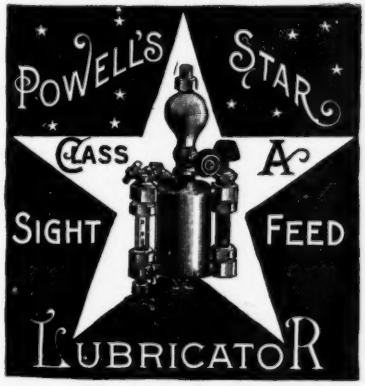

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Advertising Experts.

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Air and Gas Compressors.

Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
E. W. Bliss Co., Brooklyn, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Wks, 26 Cortlandt St., N.Y.
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Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

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Pittsburg Reduction Co., Pittsburg, Pa.

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Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

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Passaic Rolling Mill Co., Paterson, N. J.
Winslow Bros. Co., Chicago, Ill.

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Cincinnati Corrugating Co., Piqua, Ohio.
Merchant & Co., Inc., Philadelphia, Pa.
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Marion Steam Shovel Co., Marion, Ohio.

Batteries, Electric.

Electric Storage Battery Co., Philadelphia, Pa.

Belt Cement.

Shultz Belting Co., St. Louis, Mo.

Belt Dressing.

Jos. Dixon Crucible Co., Jersey City, N. J.
Shultz Belting Co., St. Louis, Mo.

Belting.

Boston Belting Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.
Main Belting Co., Philadelphia, Pa.
New York Belting & Packing Co., Ltd., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing.

Bristol Co., Waterbury, Conn.

Bending Rolls.

Hilles & Jones Co., Wilmington, Del.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

Blacksmiths' Tools.

Buffalo Forge Co., Buffalo, N. Y.
The Montgomery Company, 105 Fulton St., N. Y.

Blast Furnaces, Gas.

American Gas Furnace Co., Elizabeth, N. J.

Blowers.

American Blower Co., Detroit, Mich.
American Gas Furnace Co., Elizabeth, N. J.
Buffalo Forge Co., Buffalo, N. Y.
Gates Iron Works, Chicago, Ill.
B. F. Sturtevant Co., Boston, Mass.

Boats, Sheet Steel.

W. H. Mullins, Salem, Ohio.

Boilers.

Abendroth & Root Mfg. Co., 28 Cliff St., New York.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Edw. P. Allis Co., Milwaukee, Wis.
Cahall Sales Department, Pittsburg, Pa.
Chandler & Taylor Co , Indianapolis, Ind.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Gates Iron Works, Chicago, Ill.
The Hazelton Boiler Co., 716 E. 13th St., New York.
Heine Safety Boiler Co., St. Louis, Mo.
Pittsburg Locomotive Works, Pittsburg. Pa.
Willis Shaw, Chicago, Ill.
Stearns Manufacturing Co., Erie, Pa.
Stirling Co., Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.

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Reliance Gauge Co., Cleveland, Ohio.
Vulcan Iron Works, Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Boiler Inspectors.

Hartford S. B. I. & Ins. Co., Hartford, Conn.

Bolt Cutters.

Acme Machinery Co., Cleveland, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

For Alphabetical Index to Advertisers, see page 21.

Bolt and Rivet Headers.

Acme Machinery Co., Cleveland, Ohio.

Books.

Wm. T. Comstock, 23 Warren St. New York.
The Engineering Magazine, 120-122 Liberty St., N. Y.
Laborer's Instruction Publishing Co., St. Louis, Mo.
Ward & Gow, Union Sq., New York.

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Passaic Rolling Mill Co., Paterson, N. J.

Bridge Railing.

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N. & G. Taylor Co., Philadelphia, Pa.
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Robt. Wetherill & Co., Chester, Pa.

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Cableways.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
H. Channon Company, Chicago, Ill.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

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F. D. Cummer & Son Co., Cleveland, Ohio.

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Chrome Steel Works, Brooklyn, N. Y.

Card Index Files.

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Car Shop Machinery.

The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

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Jeffrey Mfg. Co., Columbus, Ohio.
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Ohio Pipe Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Walworth Manufacturing Co., Boston, Mass.
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Atlas Cement Co., 143 Liberty St., New York.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Philadelphia, Pa.

Chemical Works Machinery.

Atlantic Works, East Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Standard Tool Co., Cleveland, Ohio.

Clay Working Machinery.

W. J. Clark & Co., Salem, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Clutches, Friction.

Robert Poole & Son Co., Baltimore, Md.

Coal and Ashes Handling Machinery.

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Link-Belt Engineering Co., Philadelphia, Pa.

Coal Mining Machinery.

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W. J. Clark & Co., Salem, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
General Electric Co., 44 Broad St., New York.
C. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.

For Alphabetical Index to Advertisers, see page 21.

Sullivan Machinery Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coal Washing Machinery.

Cuninghame & Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

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Q. & C. Co., Chicago, Ill.

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Clayton Air Compressor W'ks, 26 Cortland St., N. Y.
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Deane Steam Pump Co., Holyoke, Mass.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.

Consulting Engineers.

Alton D. Adams, Worcester, Mass.
D. Ashworth, Pittsburg, Pa.
Bryan & Humphrey, St. Louis, Mo.
Blood & Hale, Boston, Mass.
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Century Engineering Co., Cleveland, Ohio.
C. M. Conradson, Madison, Wis.
M. Fargusson, Southport, N. C.
E. B. Hussey, Seattle, Wash.
Julian Kennedy, Pittsburg, Pa.
A. L. McRae, St. Louis, Mo.
Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
H. B. Roelker, 41 Maiden Lane, New York.
Sargent & Lundy, Chicago, Ill.
Wm. O. Webber, Boston, Mass.

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A. B. Bowers, San Francisco, Cal.
Century Engineering Co., Cleveland, Ohio.
D. Cuozzo, 150 Nassau St., New York.
Julian Kennedy, Pittsburg, Pa.

Contractors' Dump Cars, etc.

Gates Iron Works, Chicago, Ill.

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John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Chicago Flexible Shaft Co., Chicago, Ill,
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Phila., Pa.
Willis Shaw, Chicago, Ill.
Stearns Manufacturing Co., Erie, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.

Conveying Machinery.

W. J. Clark & Co., Salem, Ohio.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link-Belt Engineering Co., Phila., Pa.

Copper.

Canadian Copper Co., Cleveland, O.
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Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
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Berlin Iron Bridge Co., East Berlin, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
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Crushers, Ore, Phosphate, Rock.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Willis Shaw, Chicago, Ill.

Diamond Drills.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 100 Broadway, N. Y.

Dies and Die Forgings.

E. W. Bliss Co., Brooklyn, N. Y.
The Montgomery Company, 105 Fulton St., N. Y.
Toledo Machine and Tool Co., Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Digesters.

Atlantic Works, East Boston, Mass.

Drawing Instruments and Materials.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
The Montgomery Company, 105 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.

Dredging Machines.

A. B. Bowers, San Francisco, Cal.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

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Drilling Machines.

W. F. & John Barnes Co., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Hamilton Machine Tool Co., Hamilton, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Hammers.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Fladd Press Co., Watertown, N. Y.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Boston, Mass.

Dynamos.

American Engine Co., Bound Brook, N. J.
H. B. Coho & Co., 203 Broadway, New York.
General Electric Co., 44 Broad St., New York.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Boston, Mass.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Machinery and Supplies.

American Engine Co., Bound Brook, N. J.
Bristol Co., Waterbury, Conn.
H. B. Coho & Co., 203 Broadway, New York.
Electric Storage Battery Co., Philadelphia, Pa.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Queen & Co., Inc., Philadelphia, Pa.
Wm. E. Quimby, 59 Liberty St., New York.
B. F. Sturtevant Co., Boston, Mass.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
H K. Porter & Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Elevators.

Gates Iron Works. Chicago, Ill.
Morse, Williams & Co., Philadelphia, Pa.
Triumph Electric Co., Cincinnati, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Emery Wheels.

The Montgomery Company, 105 Fulton St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.

Chicago Flexible Shaft Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc., Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.

Engines, Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Otto Gas Engine Works, Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Marine.

Atlantic Works, East Boston, Mass.

Engines, Stationary.

J. B. Alfree Mfg. Co., Indianapolis, Ind.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J.
American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
John F. Byers Machine Co., Ravenna, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chandler & Taylor Co., Indianapolis, Ind.
Filer & Stowell Co., Milwaukee, Wis.
Frick Company, Waynesboro, Pa.
Gates Iron Works, Chicago, Ill.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Machine Co., Pittsburg, Pa.
Robert Wetherill & Co., Chester, Pa.

Excavators.

A. B. Bowers, San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, New York.
Vulcan Iron Works, Toledo, Ohio.
Willis Shaw, Chicago, Ill.

Fans, Ventilating.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
B. F. Sturtevant Co., Boston, Mass.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Fuel Economizer Co., Matteawan, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Whitlock Coil Pipe Co., Elmwood, Conn.

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Feed-Water Purifiers.

Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Filters.

Morison-Jewell Filtration Co., 26 Cortland St., N.Y.

Fire Hydrants.

M. J. Drummond, 192 Broadway, New York.
R. D. Wood & Co., Philadelphia, Pa.

Flexible Shafts.

Chicago Flexible Shaft Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Robert Poole & Son Co., Baltimore, Md.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
The Montgomery Company, 105 Fulton St., N. Y.
B. F. Sturtevant Co., Boston, Mass.

Forgings, Iron and Steel.

Chester B. Albree, Allegheny, Penna.

Furnace Builders.

Julian Kennedy, Pittsburg, Pa.

Furniture.

Globe Company, Cincinnati, Ohio.

Furniture and Chair Machinery.

The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Gages, Pressure, Steam, Water, etc.

Bristol Co., Waterbury, Conn.
The Montgomery Company, 105 Fulton St., N. Y
Walworth Manufacturing Co., Boston, Mass.

Gas Fixtures.

Walworth Manufacturing Co., Boston, Mass.

Gas Holders.

R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gas Machines and Generators.

American Gas Furnace Co., Elizabeth, N. J.
United Gas Improvement Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gas Plants.

American Gas Furnace Co., Elizabeth, N. J.
United Gas Improvement Co., Philadelphia, Pa.

Gas Producers.

R. D. Wood & Co., Philadelphia, Pa,
United Gas Improvement Co., Philadelphia, Pa.

Gas Works Machinery.

R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gate Valves.

Jenkins Brothers, 71 John St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Gear Cutters.

E. W. Bliss Co., Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
Jeffrey Mfg. Co., Columbus, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
New Process Rawhide Co., Syracuse, N. Y.
Morse, Williams & Co., Philadelphia, Pa.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Girders.

Chester B. Albree, Allegheny, Penna.
Berlin Iron Bridge Co., East Berlin, Conn.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., Chicago, Ill.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Grips, Cable Railways.

Robt. Wetherill & Co., Chester, Pa.

Guns.

Marlin Fire Arms Co., New Haven, Conn.

Hangers.

SEE PULLEYS, ETC.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
Walworth Manufacturing Co., Boston, Mass.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.

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Thomas Carlin's Sons, Allegheny, Pa.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Willis Shaw, Chicago, Ill.
Stearns Manufacturing Co., Erie, Pa.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio

Hollow Bricks.

Henry Maurer & Son, 420 E. 23d St., New York,

Hydrants.

R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Cement.

Atlas Cement Co., 143 Liberty St., New York.

Hydraulic Machinery.

Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.

Indicators, Steam-Engine.

Queen & Co., Inc., Philadelphia, Pa.

Injectors.

American Injector Co., Detroit, Mich.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.
Wm. Sellers & Co., Philadelphia, Pa.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

The Okonite Co., Ltd., 253 Broadway, N. Y.

Iron.

Passaic Rolling Mill Co., Paterson, N. J.

Joists, Iron and Steel.

Chester B. Albree, Allegheny, Penna.
Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Kiers.

Atlantic Works, East Boston, Mass.

Kyanizing.

Otis Allen & Son, Lowell, Mass.

Lamps, Electric.

General Electric Co., 44 Broad St., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.

W. F. & John Barnes Co., Rockford, Ill.
E. W. Bliss Co., Brooklyn, N. Y.
Bradford Mill Co., Cincinnati, Ohio.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Hamilton Machine Tool Co., Hamilton, Ohio.
Jones & Lamson Mch. Co., Springfield, Vt.
The Montgomery Company, 105 Fulton St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Link Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa,
Pittsburg Locomotive Works Pittsburg, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Stearns Manufacturing Co., Erie, Pa.

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburg, Pa.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

Acme Machinery Co., Cleveland, Ohio.
W. F. & John Barnes Co., Rockford, Ill.
E. W. Bliss Co., Brooklyn, N. Y.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., Chicago, Ill.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Hilles & Jones Co., Wilmington, Del.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Hamilton Machine Tool Co., Hamilton, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Q. & C. Co., Chicago, Ill.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Standard Tool Co., Cleveland, Ohio.
Stearns Manufacturing Co., Erie, Pa.
Stiles & Fladd Press Co., Watertown, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Strange Forged Twist Drill Co., New Bedford, Mass.
Toledo Machine and Tool Co., Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.
Worcester Machine Screw Co., Worcester, Mass.

Marine Machinery.

Lambert Hoisting Engine Co., Newark, N. J.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc. Philadelphia, Pa.

Merchant Steel.

Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Metals.

Wm. Jessop & Sons, Ltd., 91 John St., N. Y.
Merchant & Co., Inc., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Metal Lath.

Cincinnati Corrugating Co., Piqua, Ohio.

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Metal Punching and Shearing.
Harrington & King Perforating Co,, Chicago, Ill.

Meters, Electric.
General Electric Co., 44 Broad St., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Meters, Water.
Builders Iron Foundry, Providence, R. I.

Milling Machines.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

Mine Cars.
Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.

Mining Machinery
Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Mining Screens.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.
American Engine Co., Bound Brook, N J.
H. B. Coho & Co., 203 Broadway, New York.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Boston, Mass.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Naphtha Gas Machines.
American Gas Furnace Co., Elizabeth, N. J.

Nickel.
Canadian Copper Co., Cleveland, O.
Orford Copper Co., 37 Wall St., New York.

Office Furniture.
Globe Company, Cincinnati, Ohio.

Oil Cups.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Powell Co., Cincinnati, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Oil Gas Plants.
American Gas Furnace Co., Elizabeth, N. J.

Ore Dressing Machinery.
Cuninghame & Co., Chicago, Ill.

Ore Roasting Machinery.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.

Ornamental Iron Work.
Chester B. Albree, Allegheny, Penna.
Winslow Bros. Co., Chicago, Ill.

Packing.
Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., N. Y.
H. W. Johns Mfg Co., New York.
The Montgomery Company, 105 Fulton St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
H. W. Johns Mfg. Co., New York.
Edward Smith & Co., 45 Broadway, New York.
Joseph Dixon Crucible Co., Jersey City, N. J.

Paper Mill Machinery.
Jeffrey Mfg. Co., Columbus, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Patents.
Munn & Co., 361 Broadway, New York.

Pattern Makers Machinery.
The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Penstocks.
Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds).
Harrington & King Perforating Co., Chicago, Ill.

Phosphor Bronze.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.

Pipe, Cast Iron.
M. J. Drummond, 192 Broadway, New York.
Jeanesville Iron Works, Jeanesville, Pa.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walworth Manufacturing Co., Boston, Mass.
B. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.
National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.
Michigan Pipe Co., Bay City, Mich.

Pipe Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.
Walworth Manufacturing Co., Boston, Mass.

Pipe Dies.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast Iron.
Walworth Manufacturing Co , Boston, Mass.

Pipe, Spiral Riveted.
Abendroth & Root Mfg. Co., 28 Cliff St., N. Y.

Pipe, Wrought Iron.
Walworth Manufacturing Co., Boston, Mass.

Planers.
Hilles & Jones Co., Wilmington, Del.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

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Planing Mill Machinery.
The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Plumbers Tools and Supplies.
Walworth Manufacturing Co., Boston, Mass.

Portable Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Portland Cement.
Atlas Cement Co., 143 Liberty St., New York.

Power Hammers.
E. W. Bliss Co., Brooklyn, N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Stiles & Fladd Press Co., Watertown, N. Y.

Power Punches and Shears.
E. W. Bliss Co., Brooklyn, N. Y.
Hilles & Jones Co., Wilmington, Del.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Stiles & Fladd Press Co., Watertown, N. Y.
R. D. Wood & Co., Philadelphia, Pa,

Power Transmission Machinery.
Filer & Stowell Co., Milwaukee, Wis.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co , Philadelphia, Pa.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Preservation of Lumber.
Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic, Etc.
Niles Tool Works, Hamilton, Ohio.
Stiles & Fladd Press Co., Watertown, N. Y.
Toledo Machine and Tool Co., Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Prospecting Drills.
American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulley Covers.
Shultz Belting Co., St. Louis, Mo.

Pulleys, Shafting and Hangers.
Edw. P. Allis Co., Milwaukee, Wis.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.

Pulverizers.
Bradley Pulverizer Co., Boston, Mass.

Pumps and Pumping Machinery.
American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Filer & Stowell Co., Milwaukee, Wis.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Gates Iron Works, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeanesville Iron Works, Jeanesville, Pa.
John H. McGowan Co., Cincinnati, Ohio.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Wm. E. Quimby, 120 Liberty St., New York.
Willis Shaw, Chicago, Ill.
Stillwell-Bierce & Smith-Valle Co., Dayton, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Quarrying Machinery.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 100 Broadway, N. Y.
Willis Shaw, Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiator Screens
Harrington & King Perforating Co., Chicago, Ill.

Radiators.
H. B. Smith Co., 137 Center St., N. Y.

Railroad Ditchers.
Jeffrey Mfg. Co., Cleveland, O.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Railway Car Brakes.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railway Feed Wires.
The Okonite Co., Limited, 253 Broadway, N. Y.

Railway Shop Machinery.
Chester B. Albree, Allegheny, Penna.
Armstrong Mfg. Co., Bridgeport, Conn.
W. F. & John Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., Chicago, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works, Hamilton, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Q. & C. Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson & Stillman Co., 210 E. 43d St., New York.

Railway Specialties.
Harrington & King Perforating Co., Chicago, Ill.
H. K. Porter & Co., Pittsburg, Pa.
Q & C Co., Chicago, Ill.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railways, Portable.
C. W. Hunt Co., 45 Broadway, N. Y.

Rawhide Pinions.
New Process Rawhide Co., Syracuse, N. Y

Reducing Valves.
Ross Valve Co., Troy, N. Y.

Refrigerating Machinery.
Frick Company, Waynesboro, Pa.

Riveting Machines.
Chester B. Albree, Allegheny, Penna.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
D. R. Wood & Co., Philadelphia, Pa.

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Road-Making Machinery.

O. S. Kelly Co., Springfield, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Road Rollers.

O. S. Kelly Co., Springfield, Ohio.

Rock Breakers.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Gates Iron Works, Chicago, Ill.
Willis Shaw, Chicago, Ill.

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Clayton Air Compressor Works, 26 Cortlandt St., N. Y.
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 100 Broadway, N. Y.
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Robert Poole & Son Co., Baltimore, Md.

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Cincinnati Corrugating Co., Piqua, Ohio.
H. W. Johns Mfg. Co., New York.
Merchant & Co., Inc., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.

Roofs, Iron, Truss.

Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Rope Transmission.

C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Phila. Pa.,

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Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Rust Preventive.

Marlin Fire Arms Co., New Haven, Conn.

Saw Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Chandler & Taylor Co., Indianapolis, Ind.
Filer & Stowell Co., Milwaukee, Wis.

Schools.

Bliss School of Electricity, Washington, D. C.
Columbia University, New York.
Correspondence School of Technology, Cleveland, Ohio.
International Correspondence Schools, Scranton, Pa.
Lehigh University, South Bethlehem, Pa.
Michigan College of Mines, Houghton, Mich.
Purdue University, La Fayette, Ind.
Rose Polytechnic Institute, Terre Haute, Ind.

Screens, Mining.

Gates Iron Works, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Screen Plates, Punched.

Harrington & King Perforating Co., Chicago, Ill.

Screw Machines.

Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Niles Tool Works, Hamilton, Ohio.

Separators, Coal and Ore.

F. D. Cummer & Son Co., Cleveland, Ohio.

Separators, Steam.

Harrison Safety Boiler Works, Philadelphia, Pa.

Shafting.

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Sheet Metal Tools.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Fladd Press Co., Watertown, N. Y.
Toledo Machine and Tool Co., Toledo, Ohio.

Shoes and Dies.

Chrome Steel Works, Brooklyn, N. Y.
Gates Iron Works, Chicago, Ill.

Smokestacks.

Clonbrock Steam Boiler Co., Brooklyn, N. Y.

Spark Guards, Perforated.

Harrington & King Perforating Co., Chicago.

Steam Regulating Appliances.

Detroit Lubricator Co., Detroit, Mich.
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Jenkins Brothers, 71 John St., N. Y.
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Wm. Powell Co., Cincinnati, Ohio.
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Wm. Jessop & Sons, Ltd., 91 John St., N. Y.
Passaic Rolling Mill Co., Paterson, N. J.

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Stokers.

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Electric Storage Battery Co., Philadelphia, Pa.

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Strange Forged Twist Drill Co., New Bedford, Mass.

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Jenkins Brothers, 71 John St., N. Y.
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The Montgomery Company, 105 Fulton St., N. Y.
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Ross Valve Co., Troy, N. Y.
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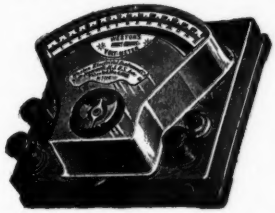

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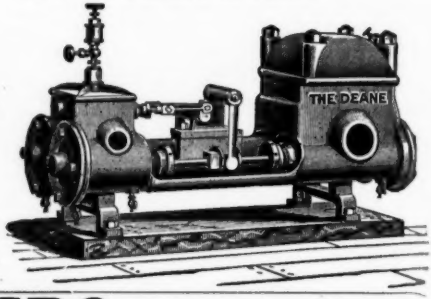

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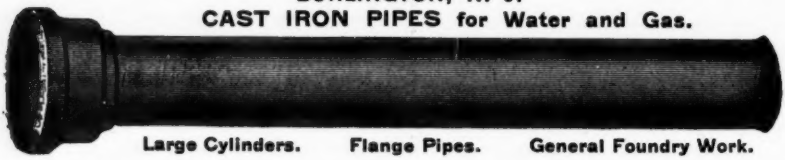

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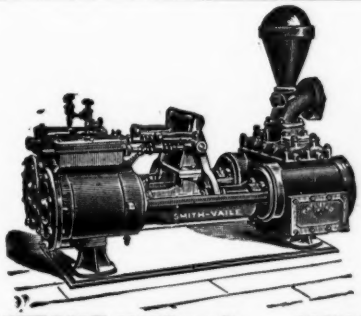

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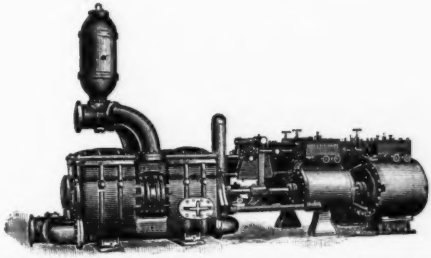

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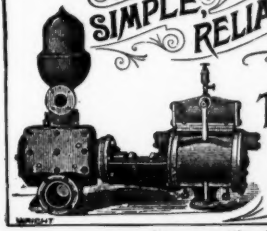

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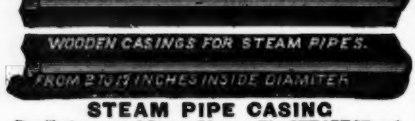

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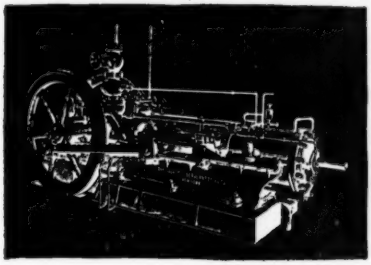

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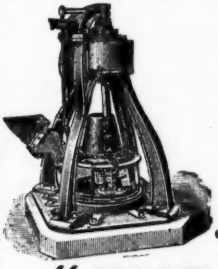

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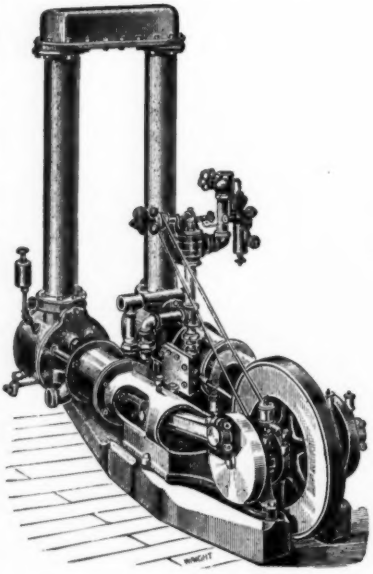

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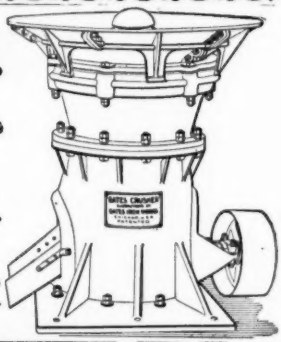

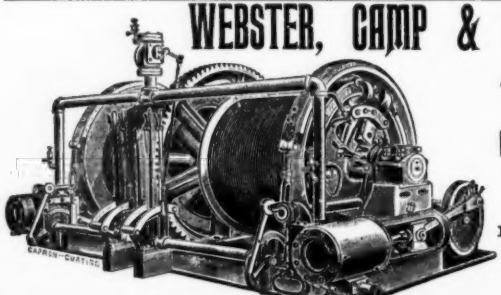

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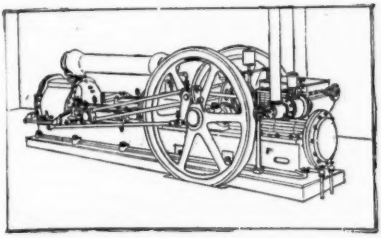

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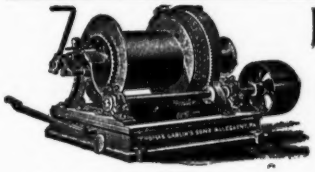

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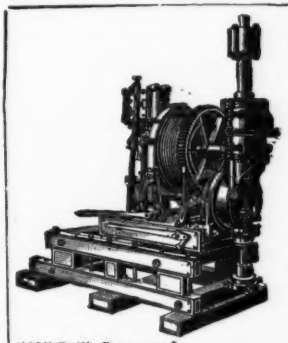

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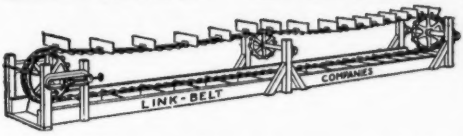

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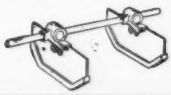

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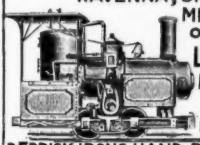

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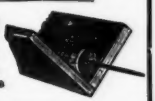

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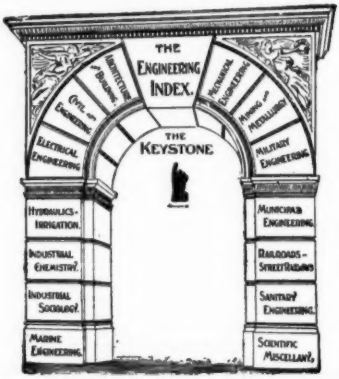

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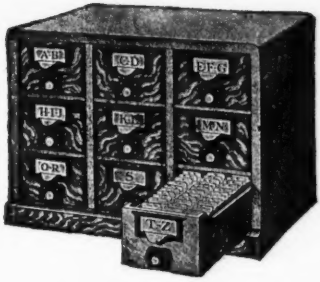

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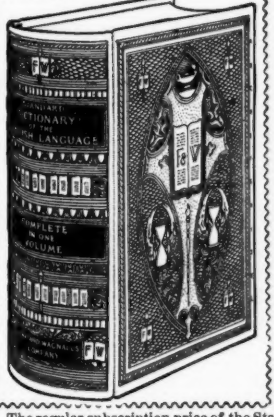

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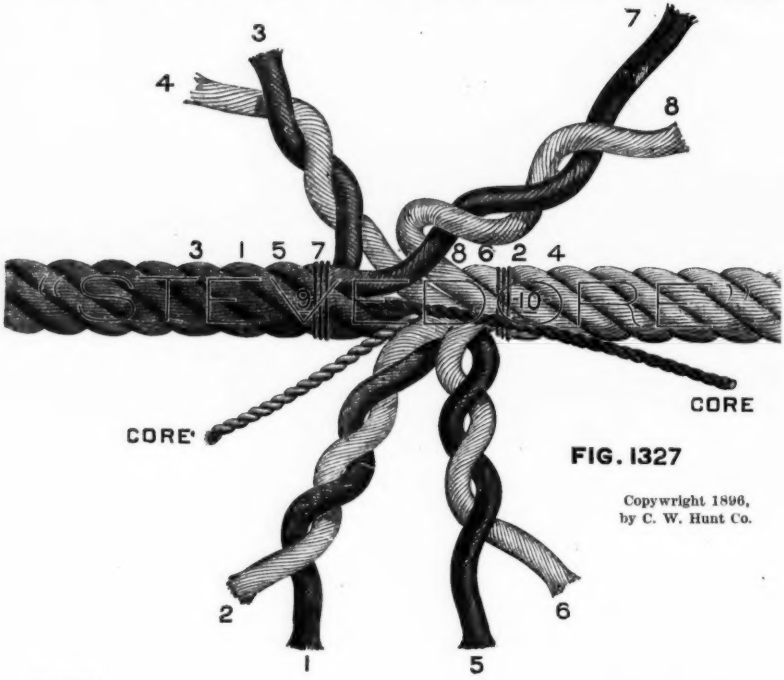

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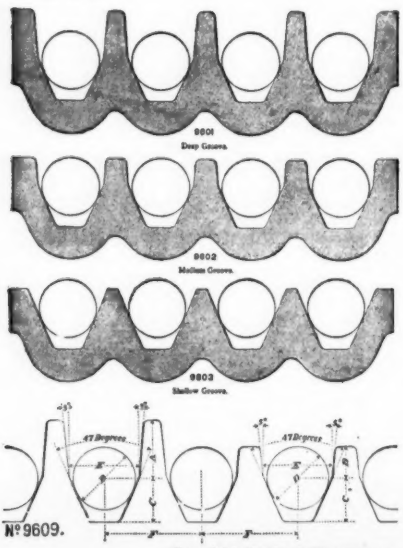

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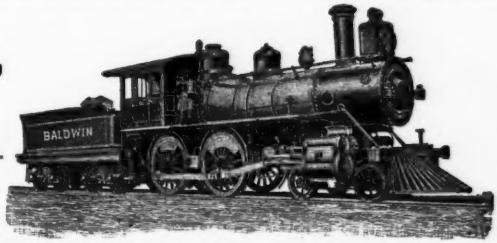

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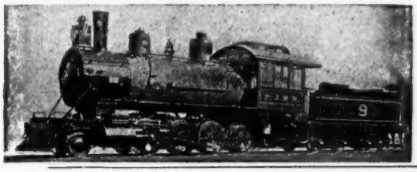

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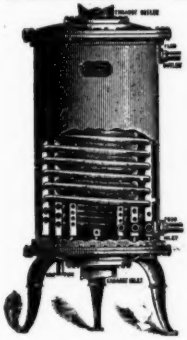

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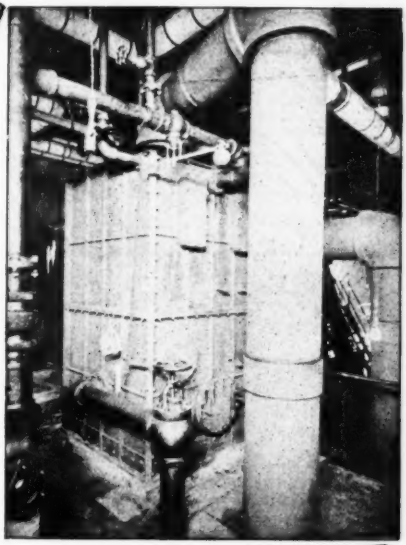

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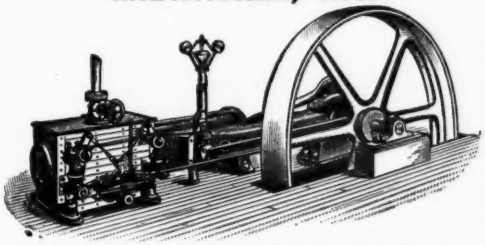

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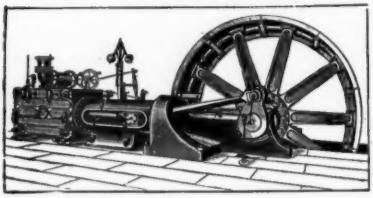

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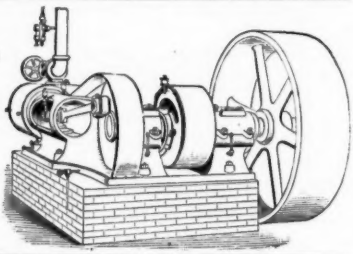

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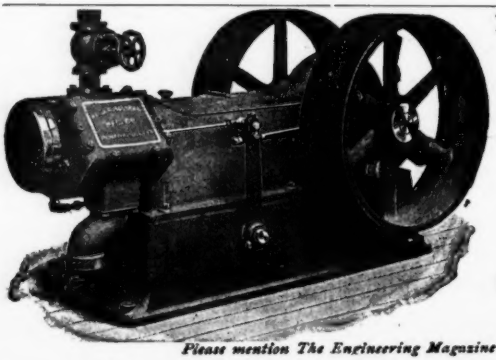

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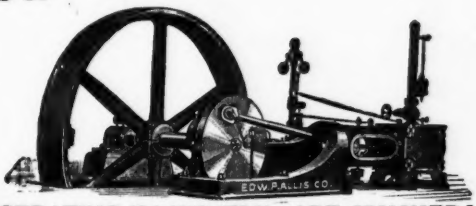

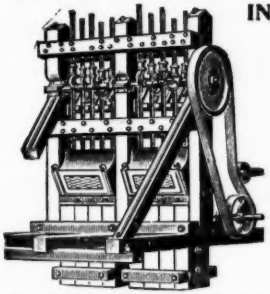

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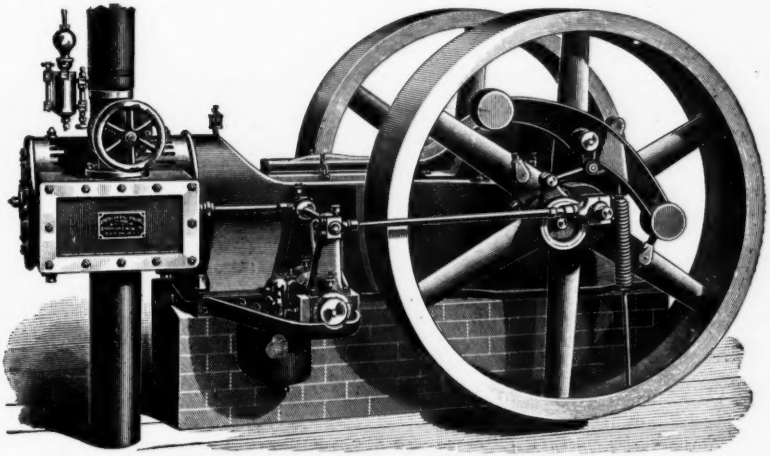

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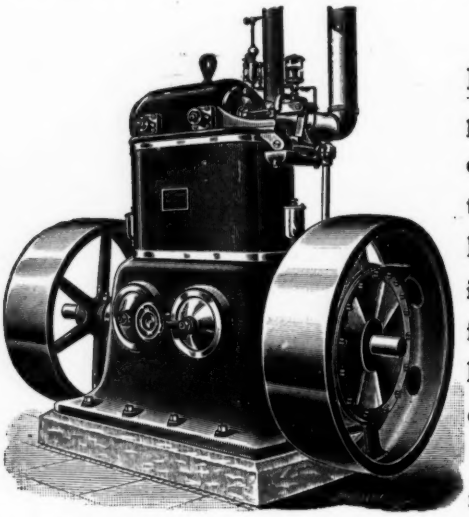

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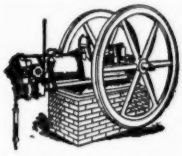

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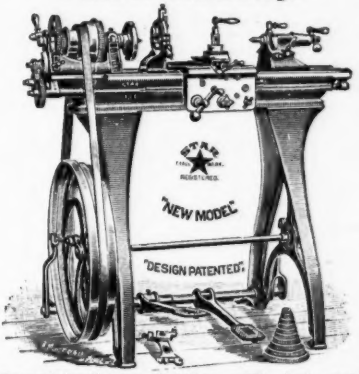

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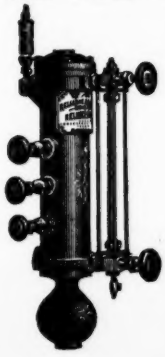

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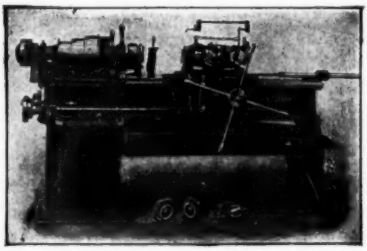

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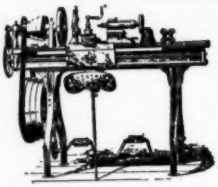

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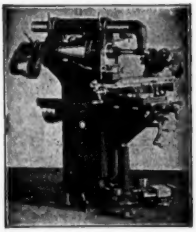

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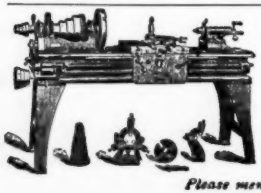

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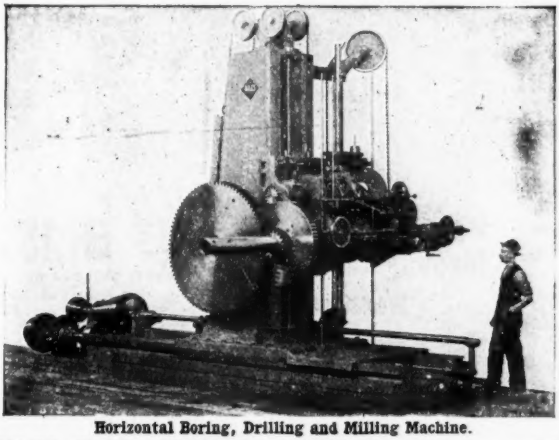

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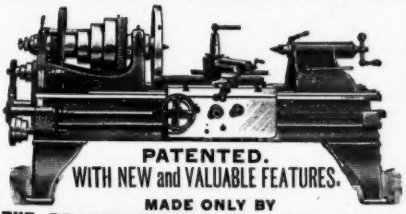

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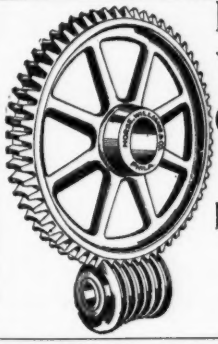

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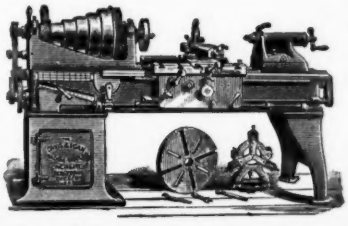

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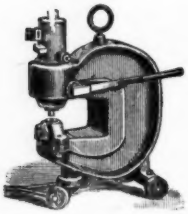

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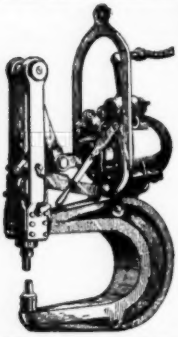

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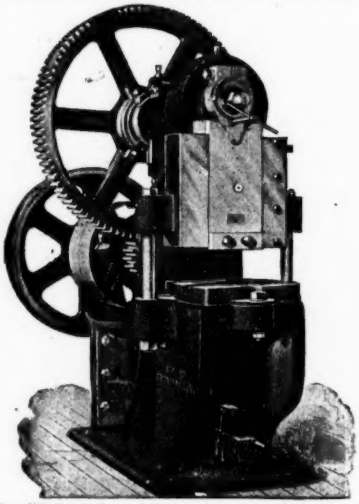

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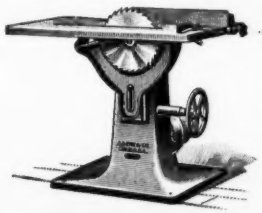
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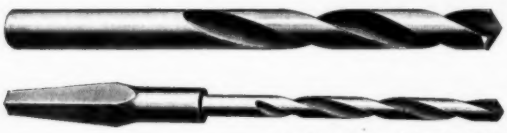

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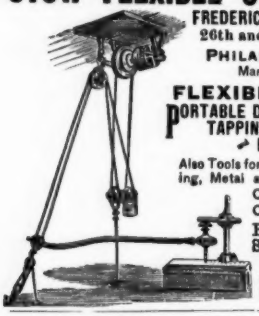

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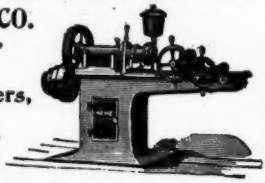

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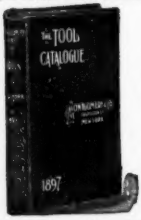

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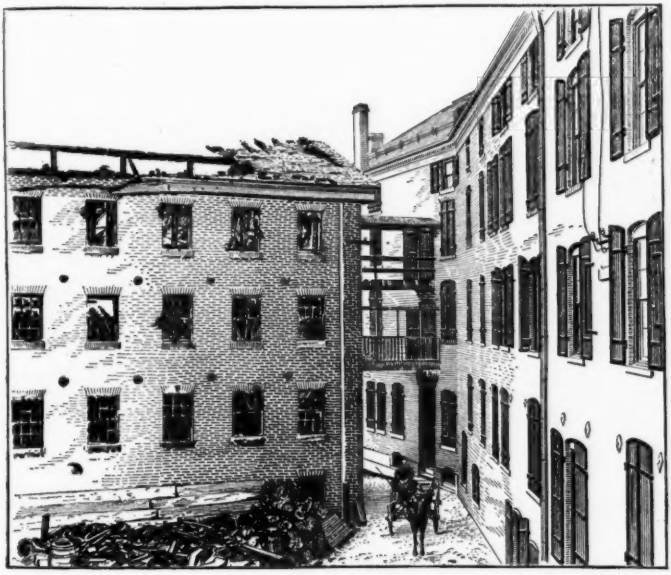

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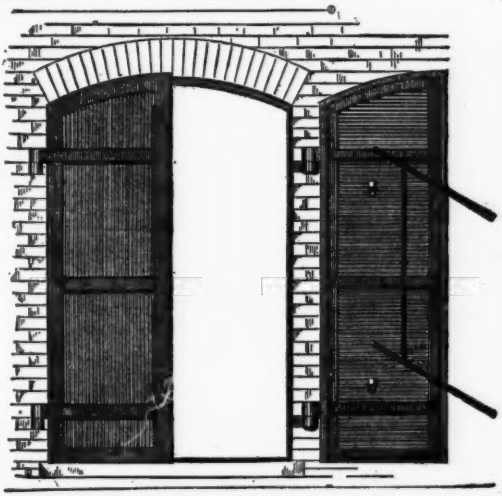

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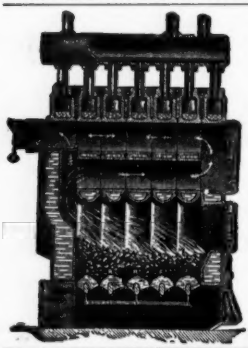

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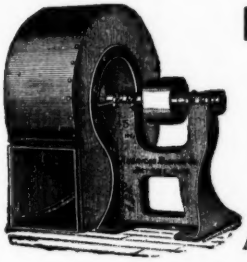

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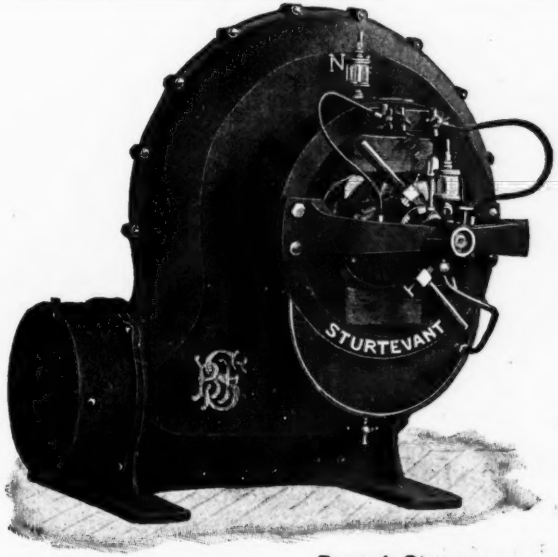

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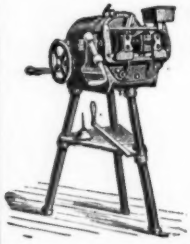

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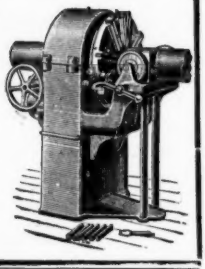

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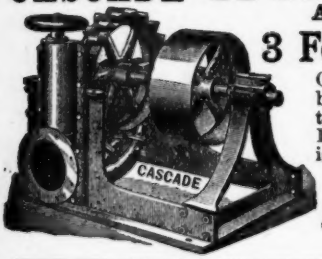

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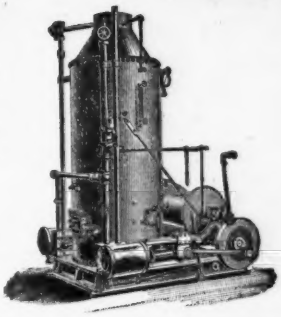

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